Eating Habits and Body Weight Control Methods of National Hunt and Flat Race Jockeys in the UK

A Dissertation submitted in partial fulfillment of the requirements for the Degree of Master of Science in Exercise and Nutrition Science

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Abstract

Horse racing is a high risk sport requiring jockeys to have strength, balance, cardiovascular fitness, specific handling skills and the ability to maintain high levels of concentration. Racing's handicapping system makes it unique because the ability of the horse determines the jockey's weight with jockeys being required to make weight repeatedly and for prolonged periods year round. Jockeys must weigh-out 30 minutes prior to a race and maintain their weight throughout to weigh-in again immediately after with no opportunity to refuel or rehydrate. The challenges of making weight appear to be an entrenched and accepted culture of the sport.

Forty-six jockeys (29 National Hunt, 12 Flat and 5 Dual Purpose) completed a 27 item questionnaire designed to gather information on the methods of weight control used and the perceived associated negative physiological or psychological effects.

National Hunt jockeys were taller (p=0.006) and significantly heavier at their non-racing weight and lowest racing weights than flat (p=0.000; p=0.000) and dual purpose jockeys (p=0.001; p=0.004). Dual purpose jockeys were heavier than flat jockeys at their non-racing and lowest racing weights (p=0.008; p=0.002). Only National Hunt jockeys had a significantly heavier non-racing weight than lowest racing weight (p=0.000). Rapid weight loss methods were used 1±1.5 days prior to a race. There were no significant differences between weight control methods, perceived negative effects or between jockey codes. Several weight control methods were associated with a number of negative physiological and psychological effects. The strongest correlations existed for weight control methods promoting dehydration, fluid restriction, sauna, hot salt bath and exercise induced sweating. Jockeys often have low levels of body fat and increased muscle mass and therefore induce dehydration to further reduce their body weight. Jockey code does not influence weight control demands as flat jockeys tend to be naturally shorter and lighter than their National Hunt counterparts.

Declaration

This paper is original and has not been submitted previously in support of a degree qualification or other course.

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CHAPTER 1

INTRODUCTION

1.0 Introduction

Horse racing makes a major contribution to the economy in the United Kingdom. Taking place year round, a total of 1,392 race meetings took place in 2010 on the country's sixty racecourses (British Horseracing Authority, 2011). Race fixtures are either Flat races that take place over short distances and contain no obstacles or fences or National Hunt races that take place over longer distances and include a number of obstacles (British Horseracing Authority, 2011).

Horse racing is a weight categorised sport that requires strength, balance, cardiovascular fitness, specific handling skills and the ability to maintain high levels of concentration (Greenaway, O'Connor & Stewart, 2010). As in many other weight categorised sports such as boxing, wrestling and lightweight rowing, jockeys are required to 'make weight' prior to competition however horse racing is unique amoungst weight category sports for a number of reasons (Dolan, 2010; Sullivan, 2008).

Firstly, in horseracing the jockeys bodyweight is used to provide the handicap for the horse (Burke, 2007). A horse's handicap is determined by the horses offical rating, used as a measure of how successful they have been previously. The actual weight that they then carry in the race is determined by the horses handicap in relation to the other runners in the race (UK Horseracing, 2012). The aim of the handicap weights is to promote a fair and interesting race (Burke, 2007).

Secondly horseracing takes place throughout the year with no discernable off-season (Warrington et al., 2009) and jockeys will often have several rides per day (British Horseracing Authority, 2011). Jockeys are therefore required to 'make weight' repeatedly and for prolonged periods often with weight targets substantially below the weight for height norms for the general population and possibly substantially lower than their true body weight (Burke, 2007).

Finally, Jockeys are required to weigh out 30 mins prior to each race fully clothed and including the weight of their saddle and then, unlike in many other weight category sports, jockeys are required to weigh in again immediately following the race (Dolan, O'Connor, McGoldrick, O'Loughlin Lyons & Warrington, 2011). Due to the short time period between weighing out and the start of the race and the need to maintain their weight throughout the race, there is no opportunity to rehydrate prior to the event unlike in many other weight controlled sports (Warrington et al., 2008).

In flat racing the minimum weight is 7st 12lb and in National hunt racing 10st, however this is subject to the claims and allowances that exist for mares and amateur, apprentice and conditional jockeys in order to provide them with more opportunities in the early stages of their career (The British Horseracing Board and The Horseracing Regulatory Authority, 2007).

Most jockeys report weight management to be difficult (Moore, Timperio, Crawford, Burns & Cameron-Smith, 2002) and rapid weight loss practises commonly used include energy restriction, exercise, sauna induced sweating and laxative abuse many of which promote substantial fluid loss and are similar methods to those used in other sports such as wrestling (Moore et al., 2002; Oppliger, Nelson Steen & Scott, 2003). These weight management strategies are often deemed necessary as the body composition of jockeys typically consists of increased muscle bulk and low levels of body fat resulting in the use of wasting behaviours such as active dehydration in order to reach the required weight (Sullivan, 2008). There are few education and training programmes on diet and nutrition available to jockeys and often weight management strategies are passed on by peers (Dolan et al., 2011).

Jockeys appear to compete in a state of negative energy balance and dehydration (Sullivan, 2008). The rapid weight loss strategies commonly used by athletes have been shown to be associated with pathogenic eating behaviours as well as risks to their health and well being

(Caulfield, Karageorghis, Terry & Chatzisaranths, 2003). Marked dehydration has been observed in jockeys both on non-race days and race days (Warrington et al., 2008; Warrington et al., 2009). Weight category sports are also notorious for encouraging the development of, sustaining or attracting those individuals with a vulnerability to eating disorders (Baum, 2006).

Horse racing is a high risk sport with soft tissue injuries and fractures occuring commonly as a result of falls. These risks are exacerbated by the physiological and psychological effects of acute weight loss strategies (Dolan, 2010). The implications of such rapid weight loss methods raise questions about the implications on jockeys performance and long term health particularly as it appears that many rely on extreme, rapid weight loss methods rather than a more nutritionally balanced diet to reach their riding weights. There is little research specifically on the physiological and psychological effects of weight management in jockeys and the current study aims to investigate the methods used by both Flat and National Hunt jockeys to reduce their body mass and the self-percieved impacts on their health and well-being.

1.1 Aim

To investigate the habitual diet, lifestyle and weight making practices adopted by both Flat and National Hunt jockeys to control their weight for racing and the jockeys' perceived physical effects of wasting in the United Kingdom.

1.2 Hypotheses

All jockeys employ short term weight loss methods in order to ‘make weight’ for racing.

All jockeys actively dehydrate in an effort to reach their racing weight.

Flat race jockeys are more dependent on short term weight loss methods.

Flat jockeys experience more negative physical effects as a result of their weight control methods as a result of their weight control methods.

Flat jockeys experience more negative physiological effects as a result of their weight control methods as a result of their weight control methods.

CHAPTER 2

LITERATURE REVIEW

2.0 Thoroughbred Horseracing in the United Kingdom

Horse racing in Britain is an important part of the country's social fabric and makes a great contribution to the country's economy and to a wide variety of communities (British Horseracing Authority, 2011). After football, racing is this country's second biggest sport by a substantial margin. In 2010, 5.8 million people attended race meetings staged across all but three days of the year (British Horseracing Authority, 2011). The last economic review in 2009 showed that tax revenue from racing has amounted to some £1.5 billion over the previous five years with capital investment of over £700 million during those five years (British Horseracing Authority, 2011). The total economic impact of British racing in 2008 amounted to £3,393 million (British Horseracing Authority, 2011).

Flat and National Hunt racing takes place in the UK throughout the year, at Britain's 60 racetracks (The Racecourse Association Ltd., 2012). In 2010, 1,392 meetings took place, 481 of these were National Hunt jump meetings and 911 were flat race meetings. At these there were a total of 9,566 races (3,257 jump and 6,309 flat) and 92,025 runners (31,209 jump runners and 60,816 flat runners) (British Horseracing Authority, 2011).

In 2010, a total of 433 jockeys held a professional license. Of these 248 flat jockeys were registered, 123 of which were apprentices. Of the 185 jump jockeys registered, 92 were Conditional. In addition to this, 376 jockeys held an amateur license which is divided into two categories (see Table 1) (British Horseracing Authority, 2011).

Table 1-A description of the categories of amateur jockeys licenses and the number of license holders in 2010 (British Horseracing Authority, 2011).

Category	Number Registered	Description
A	54 Flat 46 Jump 128 Dual Purpose	Are only able to ride in races confined to amateurs
B	148	Are able to ride in amateur flat races or any steeplechase, hurdle or National Hunt flat race except those confined to licensed jockeys

2.0.1 Demands of horseracing on jockeys

Horseracing is a highly competitive and dangerous sport. Jockeys are required to have high levels of both physical and mental fitness, strength, balance and the ability to maintain high levels of concentration (Sullivan, 2008). Thoroughbred racehorses weigh up to 500kg and are capable of speeds in excess of 60 $km.h^{-1}$, often the jockeys that ride them weigh as little as 50 kg (7st 12 lbs) and they are positioned in a state of forward propulsion some 2-3m above the ground see Figure 1) (Warrington et al., 2009).

The specific physiological demands of racing are yet to be identified (Dolan et al., 2011). The energetic costs of riding will vary according to the speed, duration, type of race and race conditions as well as the type of horse being ridden (see Table 2) (Devienne & Guezennec, 2000).

Figure 1- A racehorse and jockey (Daily Mail, 2009).

Table 2-The types and distances of horse races in the United Kingdom (British Horseracing Authority, 2011; Warrington et al., 2009).

Race		**Distance**	**Obstacles**
Flat		5-20 Furlongs 0.625-2.5 Miles	No obstacles or fences
National Hunt	Hurdle	2-3 Miles	A number of hurdles 3ft 6” high
	Steeplechase	2-4.5 Miles	A number of fences up to 4 ft 6” high

All horses are different and have different technical characteristics, some are lethargic and will need to be pushed, and others are livelier and may need to be restrained (Devienne & Guezennec, 2000). Oxygen uptake varies according to the different equine gaits and can range between 40% and 80% of the rider's maximal aerobic power. Indirect measurements of the energy expenditure by heart rate of professional jockeys during a race indicate that maximal heart rate and possibly maximal aerobic power is reached during a race (Trowbridge, Cotterill & Crofts, 1995). A flat race can last as little as a few minutes where as the fastest recorded time in the Grand National, a race over four and a half miles is 8 minutes 47.8 seconds and in wet conditions, the slowest winning time was over 11 minutes (www.grandnational.org.uk). Estimated mean energy expenditure in a group of Irish flat racing jockeys (n=11) was found to be 3952±577 Kcals (16,535±2414 KJ) (Warrington et al., 2008).

2.1 Weight restrictions in sport

Making weight' in sport refers to the practice of reducing body mass prior to competition. Boxing, judo, wrestling and rowing all have weight requirements as part of the competition rules (Sullivan, 2008). Weight category athletes will make weight for a number of reasons (Dolan, 2010);

- To compete in a lower weight class
- To improve aesthetic appearance
- To improve physical performance

It has been proposed for example that many lightweight rowers would be unable to compete as successfully in the heavyweight category due to limitations in their height and/or strength and therefore in order to compete in lightweight categories they may risk being drawn towards pathogenic weight loss strategies (Terry, Lane & Warren, 1999).

Depending on the amount of body fat needing to be lost, the amount of time available and weight loss mechanisms used, a significant physiological and psychological stress is placed on the athlete (Dolan, 2010). Types of weight loss methods used in different sports are comparable and all will have similar negative effects (Sullivan, 2008). A moderate decrease in energy intake may induce a loss of body mass without adversely affecting performance but if the body mass loss is greater than that which is physiologically tolerable, it does appear to have an impact on athletic performance (Dolan, 2010).

Ideally, any reductions in body weight should be done in the athlete's off-season over a period of more than seven days so that the reduction in mass is from the adipose tissue compartment and not due to body water loss (Dolan, 2010). For many athletes this is not always practical or possible and many resort to acute weight loss practices including energy restriction and active or passive dehydration techniques (Dolan, 2010).

Boxers and wrestlers face the potential threat of exclusion from competition if they exceed the specified weight limit for their division however unlike jockeys they do have time between weighing-in and competing to refuel and rehydrate (Sullivan, 2008). Providing the appropriate recovery strategies are implemented, a period of time such as 24 hours between weighing-in and competition has previously been shown to attenuate the physiological strain associated with a rapid reduction in body weight (Dolan, 2010).

2.1.1 Weight restrictions and handicapping in horse racing

Weight restrictions in horse racing were historically designed to safeguard the health of the horse (Caulfield & Karageorghis, 2008) and each individual horse is allocated a weight or 'handicap' based solely on the ability of the horse with the aim of maximising the competitiveness of professional racing (Dolan, 2010).

Handicapping is an integral feature of horse racing in which horses of varying levels of ability are brought together to create a level playing field with better horses carrying more weight than poorer horses to allow all horses to have an equal chance of winning if they run to the best of their ability (British Horseracing Authority, 2011). More experienced, successful horses will race in graded races which are run at level weights depending on the grade of the race although some of which are also subject to riders allowances being claimed (The orders and rules or racing, 2007). Mares also receive allowances in all races other than in handicaps except those confined to mares (The British Horseracing Board and The Horseracing Regulatory Authority, 2007);

- 5lbs or 3lbs for flat Racing depending on the grade of the race
- 7lbs or 3lbs for National Hunt Racing depending on the grade of the race

The weight carried by a horse in a handicap is determined by the horse's official rating which is given to all horses after it has won or completed three races finishing in the top six positions in at least one of them (UK Horseracing, 2012). The actual weight then carried by a horse in a handicap is in relation to the ratings of the other runners in the race for example a horse with a rating of 55 will carry 10lbs less than a horse rated 65. These ratings are reviewed weekly by the handicapper and adjusted according to how it performs (UK Horseracing, 2012).

The minimum weight carried in flat racing is 7 stone 12 lbs unless a rider's allowance is claimed or the race is restricted to apprentice jockeys (see Table 3) (The British Horseracing Board and The Horseracing Regulatory Authority, 2007) this is 80lbs lower than the average for an adult male. It must be taken into consideration however that the average height of an adult male is 1.77m and the average height of a flat race jockey is only 1.58m (Caulfield & Karageorghis, 2008). The minimum weight for National Hunt racing is 10 stone subject to riders allowances or restrictions for conditional jockeys (see Table 3) (The British Horseracing Board and The Horseracing Regulatory Authority, 2007).

Table 3- Riders allowances (The British Horseracing Board and The Horseracing Regulatory Authority, 2007)

	Allowance Claimed	
Flat Racing	**7 lbs**	Until won 20 races, thereafter;
	5 lbs	Until won 50 races, thereafter;
	3 lbs	Until won 95 races
National Hunt Racing	**7lbs**	Until won 20 races, thereafter;
	5lbs	Until won 40 races, thereafter;
	3lbs	Until won 75 races
Amateur Jockeys	**7lbs**	Until won 5 races, thereafter;
(in amateur races only)	**5 lbs**	Until won 10 races, thereafter;
	3 lbs	Until won 20 races

The average body mass of trainee jockeys at the Racing Academy and Centre of Education (RACE) in Ireland over the past thirty years has increased by 37% (13.6kg) yet during the same period, the minimum weight allocation for flat jockeys has increased by only 6% (Caulfield & Karageorghis, 2008; Dolan et al., 2011). Average weights of jockeys have been reported to be 13% below the mean weight of a matched population with the lowest reported to be 21% below (King & Mezey, 1987).

A jockey's body composition typically consists of high levels of muscle bulk and low levels of body fat (Sullivan, 2008), which is desirable in this population to maximise metabolic and mechanical efficiency (Warrington et al., 2009). However the minimum body fat levels necessary for health and normal metabolic function have been reported to be 5% for men and 12% for women (Dolan, 2010). A number of jockeys have reported these body fat levels which may compromise health and athletic performance (Warrington et al., 2009) and mean that in order to reduce weight further, wasting behaviours are often necessary to reach the required weight which will result in a likely loss of body water and lean tissue essential for optimal physiological function (Sullivan, 2008; Warrington et al., 2009).

Allowances claimed by inexperienced jockeys (see Table 3) reduce the horses handicap weight in an attempt to encourage trainers to give them rides on their horses and to help their career in the early stages, this practice may represent a significant challenge to the young jockey in that they must strive to attain minimal weights at a critical growth and maturation phase (Dolan, 2010; Dolan et al., 2011).

Horse racing is a unique example of a weight category sport for a number of reasons. The handicap system determines the weight allocation of a jockey not by the jockeys' individual physique but by the horses' ability. Jockeys are required to align their body mass with that allocated to their designated mount in each race (Dolan et al., 2011) and they may ride in between five and seven races per day all of differing weight allocations, any deficits are made up using lead weight fitted in a cloth under the saddle (Horseracing Database Solutions, 2012; Warrington et al., 2009).

Unlike other weight category sports in which competitors are required to weigh in prior to competition only and up to twenty four hours before competition, in horse racing jockeys are required to weigh in immediately prior to and following each race which does not allow jockeys any opportunity to replenish energy and fluid stores possibly depleted whilst making weight (Dolan et al., 2011). A 2lb allowance is given for the jockey's body protector and prior to a race a jockey must weigh-out fully clothed at the required weight including (Dolan, 2010; The British Horseracing Board and The Horseracing Regulatory Authority, 2007);

- riding boots
- body protector
- saddle
- jockeys' skull cap
- whip
- horses bridle
- plates
- blinkers
- hood
- visor
- eyeshield or eyecover
- anything worn on the horses legs

Failure to report to the clerk of the scales to weigh-in following the race results in disqualification (The British Horseracing Board and The Horseracing Regulatory Authority, 2007). If a horse carries less weight than it should throughout the race or if the rider weighs in at more than one pound less than it weighed out at it will be disqualified. If a jockey weighs in at two pounds or more over the weight at which they weighed out, the jockey will be reported to the stewards but the horse will not be disqualified (The British Horseracing Board and The Horseracing Regulatory Authority, 2007).

Finally, in contrast to other weight category sports, horse racing takes places seven days a week with no discernible off season providing jockeys with little respite from the rigours of making weight (Dolan et al., 2011; Warrington et al., 2009).

Horseracing is one of the only major sports in which men and women compete against each other and female jockeys face a gender prejudice despite the fact that the naturally smaller and lighter build of females often makes it easier for them to make the weight (Sullivan, 2008). Most jockeys report weight management to be difficult and commonly use rapid weight loss strategies including energy restriction, exercise, and sauna induced sweating and laxative use.

Despite the fact that reaching the required weight and maintaining a low body weight throughout their career clearly presents a challenge, there is little in the way of support and assistance except a four and a half day course at the British Racing School that trainee jockeys attend at the start of their careers in which only one lecture focuses on diet and nutrition (British Racing School, 2012; Caulfield & Karageorghis, 2003). Weight management strategies are often passed on by peers and rarely as a result of consultation with a health professional, the challenges of making weight appear to be an entrenched and accepted culture of the sport (Dolan et al., 2011). It would appear that jockeys who are successful are so in spite of the system (Caulfield & Karageorghis, 2003). .

Horse racing is a high risk sport with falls commonplace. The risks of injury are exacerbated by the acute weight loss strategies that possibly result in dehydration and low bone mass (Dolan, 2010). Financially racing is an uncertain profession despite the potential for high monetary rewards. There is no guarantee of securing rides let alone on horses capable of winning a race and for this reason any problems regarding performance, weight or injury are often not made public (Sullivan, 2008).

2.2 Weight management and physical well being

Although entry rights of naturally lean jockeys must be taken into consideration, a body of research suggests that many may be endangering their physical and psychological health to make weight and win rides (King & Mezey, 1987; Labadarios, Kotze, Momberg & Kotze, 1993; Leydon & Wall, 2002).

Gradual weight loss is attained through a reduced energy intake and increased energy expenditure resulting in a negative energy balance and oxidation of adipose tissue over time (Dolan, 2010). Rapid weight loss via food and fluid restriction can lead to a loss of body water and lean muscle mass needed for optimum performance in addition to compromising hydration status, muscle and liver glycogen stores and potentially circulating blood glucose concentration all of which are necessary for the maintenance of usual physiological, cognitive, metabolic and osteogenic functions (Dolan, 2010). A total loss of bodyweight of approximately 3.6 kg in absolute in national level male judo athletes represented a deficit in energy intake of approximately 7000

Kcal/week which corresponded to less than 1 kg of body fat. Most of the body weight lost was therefore due to loss of body water (Filaire, Maso, Degoutte, Jouanel & Lac, 2001).

Although gradual weight loss over a period of greater than seven days is recommended, weight category athletes tend to dramatically reduce body mass immediately before a competition in quantities far in excess of what the body can safely tolerate (Dolan, 2010). For a jockey however a gradual approach to weight loss is not always possible as their career and financial security depends on the ability to take 'light' rides at minimum notice (approximately 24 hours) (Dolan et al., 2011).

Jockeys appear to primarily follow a chronically energy restricted lifestyle and rely on regular use of rapid weight loss strategies including both passive and active dehydration, saunas, exercise in sweatsuits and abuse of laxatives which promote substantial fluid loss and are similar methods to those used in other sports such as wrestling (Dolan, 2010; Dolan et al., 2011; Moore, Timperio, Crawford, Burns & Cameron-Smith, 2002; Oppliger, Nelson, Steen & Scott, 2003). Some studies have shown abuse of diuretics amongst jockeys but their use is prohibited in the United Kingdom (The British Horseracing Board and The Horseracing Regulatory Authority, 2007).

2.3 Weight management and physical performance

Sound nutritional practises are essential for optimal athletic performance (Beals & Manore, 1998). Many athletes have suboptimal energy and nutrient intakes and are at risk of compromised nutritional status (Beals & Manore, 1998). Intense training combined with inadequate carbohydrate intakes may lead to low glycogen stores contributing to increased fatigue and risk of injury. In the first ten days of fasting, 54-58% of the body mass lost is body water, 30-35% adipose tissue stores and 6-16% protein (Dolan, 2010).

A rapid reduction in body mass in preparation for a competition can result in a loss of body water, substrate stores and lean muscle mass, all detrimental to performance (Dolan, 2010). Rapid weight loss has been associated with a reduced athletic performance in judo, boxing, wrestling and lightweight rowing (Dolan et al., 2011, Filaire et al., 2009). Trained female cyclists showed an increased time to fatigue when they consumed a high carbohydrate diet (Beals & Manore, 1998).

A negative physiological effect has been found as a result of a 5 % reduction in body mass following a seven day food restriction in a group of judoists on a 30 second maximal jumping test, but not on a 7 second maximal jumping test and a 22 second reduction in maximal rowing time was found following a 5% reduction in body mass over a 24 hour period. These performance decrements are attributed mainly to a reduced plasma volume as a result of dehydration and reduced muscle glycogen which indicates that longer duration aerobic exercise is affected to a greater degree by dehydration than shorter duration aerobically independent exercise (Dolan, 2010).

For athletes competing in weight category sports such as jockeys, rapid weight loss from the use of saunas and exercising in sweat suits and abuse of laxatives and diuretics increases the risk of dehydration and in the long term can cause chronic under-nutrition and energy deficiency. A decreased bone mass, hypohydration (especially on race days), low body fat stores and a worrying incidence of racing related injury are all attributed to a chronic weight restrictive lifestyle (Dolan et al., 2011).

2.4 Weight management and cognition

The ability to produce the appropriate emotional feeling prior to major competitions has been recognised by coaches and athletes as one of the most important factors contributing to athletic performance. Positive emotional health and successful athletic performance are thought to be correlated (Degoutte et al., 2006). Emotive and cognitive function has been found to be affected by a rapid reduction in body mass in preparation for a competition. Anger, fatigue, confusion, tension, short term memory impairment and changes in mood state have all been seen following rapid weight loss (Dolan, 2010). Athletes that are less anxious, depressed, fatigued and confused and more vigorous will be more successful than those exhibiting the opposite profile (Degoutte et al., 2006).

Rapid weight loss through starvation and dehydration as found in jockeys has also been found to have detrimental effects on wrestlers' mood and short-term memory. Wrestlers undergoing severe weight loss have been reported to experience diminished mental alertness and a more negative mood profile with high levels of anxiety, fatigue and anger in particular (Caulfield & Karageorghis, 2008).

Elevated depression, tension and confusion scores have been found in elite rowers during periods of rapid weight loss. Rapid weight loss of boxers prior to a fight can result in poor performance, fatigue, anger, tension and reduced vigour (Caulfield & Karageorghis, 2008).

It has been shown that mood can have important implications for both physical and psychological well-being and negative moods can have deleterious consequences for cognitive functioning, health and successful interpersonal relationships (Caulfield & Karageorghis, 2008). Conversely, because the impairment of cognitive functions during calorie restriction is frequently mediated by the preoccupation with food and bodyweight, it is possible that it is these obsessive thoughts about food and weight rather than calorie restriction itself that negatively affect cognitive performance (Redman, Martin, Williamson & Ravussin, 2008).

High levels of mood responses for the variable depression following wasting are of particular concern when accompanied with relatively high scores for anger, fatigue and confusion. Research has shown that in the presence of depression the other negative mood factors, particularly anger, can have debilitative effects on performance. Prolonged wasting behaviour can lead to an increase in depressive symptoms which could lead to clinical depression over time and compromise mental health (Caulfield & Karageorghis, 2008).

For jockeys all the cognitive effects of wasting can have serious ramifications for their mental and physical well-being. Anger can lead to friction with significant others leading up to race days and high levels of fatigue in particular are dangerous when driving up to hundreds of miles across the country to race meetings (Caulfield & Karageorghis, 2008).

A number of factors can affect mood and must be considered when interpreting the results of self-reported measurement of mood such as the Brunel Mood Scale (BRUMS) used in the study by Caulfield et al. (2003). Current form, interpersonal issues with trainers, injury and the horses' ability on any given day can affect the results. Jockeys may also have concerns about the implications of acknowledgement to the use of pathogenic weight control measures due to possible career threatening repercussions if sensitive information entered the public domain (Caulfield & Karageorghis, 2008).

2.5 Methods of weight control in jockeys

Regardless of age, gender or sport, athletes must consume enough food to cover the energy costs of daily living and their sport in addition to the energy costs of building and repairing muscle tissue (Dolan, 2010). A variety of homeostatic, metabolic and non-homeostatic mechanisms regulate body mass and can present a significant challenge to any athletes attempting to achieve a body mass lower than that which is homeostatically and genetically programmed (Dolan, 2010).

As previously mentioned, the naturally lean body compositions of jockeys means they often have to rely on extreme wasting behaviours in order to make the required weight (Sullivan, 2008). Jockeys appear to rely on energy restriction combined with passive or active dehydration to control their weight and often appear to compete in an energy deficient and dehydrated state (Sullivan, 2008).

2.5.1 Energy restriction and negative energy balance

Unless athletes are actively trying to lose or gain weight, energy intake and expenditure should match to ensure stable body mass and composition. The body appears to be capable of overcoming short-term discrepancies in energy balance, allowing body composition to remain relatively stable long-term (Dolan, 2010). Mean daily energy intake in a group of Irish flat jockeys (n=11) has been found to be 2229±593 Kcals (9326±2481 KJ) with a resulting energy deficit of 1723±859 kcals (7209±3594 KJ) (P=0.000). This equates to approximately 56% of the estimated energy expenditure of 3952±577 Kcals (16,535±2414 KJ) indicating a significant state of energy deficit (Warrington et al., 2008).

Seven day food diary analysis found the total estimated calorie and carbohydrate intake in a group of Irish jockeys to be quite low compared to the general athletic recommendations and their estimated metabolic rates (Dolan, 2010). Typically, a jockey's diet is low in energy and inadequate in key micronutrients (Dolan et al., 2011). The mean energy intake of 27 professional Irish jockeys was reported to be as little as 22% greater than the estimated resting metabolic rate (RMR), enough to meet the metabolic needs of men during bed rest and not a professional jockey (Dolan et al., 2011). Energy intake has previously been reported to be 1669±436 kcal (6983±1824 KJ) and 2013±707 kcal (8422±2958 KJ) for Flat and National Hunt jockeys respectively with estimated RMR for flat jockeys to be 1479±124 kcal/day (6188±518 KJ/day) and for national hunt jockeys 1614±71 kcal/day (6753±297 KJ/day) due to Flat jockeys tending to be naturally shorter and lighter in stature (Dolan et al., 2011).

It is possible that a low energy expenditure and increased energy intake on non-race days may partially compensate for the deficit in energy availability however it is unlikely that it is completely compensated for as most will ride track work on non-race days and chronically restrict food intake for subsequent race days, a substantial proportion of jockeys therefore remain in a constant state of chronic energy deficiency (Dolan et al., 2011).

Dolan et al. (2011) also found low protein intakes of 1.3±0.5 g/kg (recommended health guidelines for athletes is 1.8 g/kg protein). The protein requirements of energy deficient athletes may increase due to the oxidation of protein in order to provide energy, which may compromise its fulfilment of structural and enzymatic functions. Low carbohydrate intakes of 3.7±1.3 g/kg also failed to meet the recommended minimum intake for athletes (6g/kg). Even when energy levels are sufficient, a low carbohydrate intake has been shown to decrease the buffering capacity of the blood but acidosis due to a combination of weight loss and low carbohydrate intakes will reduce muscle hydrogen ion efflux. Fatigue during intense muscular contractions is accelerated as a result also reducing static strength (Filaire et al., 2001).

National level Judo athletes have shown reduced hand grip strength, particularly in the left hand and a significant reduction in a 30 second jumping test, a test considered to reflect anaerobic characteristics, as a result of a low carbohydrate diet and low micronutrient levels. However, no change was seen in 7 second jumping tests following weight loss due to the energy liberated from phosphagen stores being of high importance, whereas 30 second jumping performance is reduced due to an altered acid-base balance following weight loss (Filaire et al., 2001).

A high energy intake (5%) from alcohol has been found amongst male professional Irish jockeys relative to the low total energy intake reported although alcohol intake was still within the Irish public health guidelines for males. Alcohol has little nutritional value and may impair rehydration and glycogen storage after exercise (Dolan et al., 2011). The diets typically have a low intake of fresh produce (0.9±0.8 servings per day) and a strong reliance on convenience foods (2±0.5 meals/week) tending to be energy dense, high in fat and low in fibre and micronutrients. A substantial proportion indicated that smoking was used as a method of weight control with a high prevalence of current or past smokers (57%). High alcohol consumption combined with smoking has been linked to sub-optimal bone health. These results indicate that it is not just the lack of food consumed that may cause problems for jockeys but that what is consumed is of poor nutritional value (Dolan et al., 2011).

2.5.1.1 Physiological effects of energy restriction in jockeys

Acute, short-term energy restriction (48 hours) negatively affects exercise performance. A chronic state of negative energy balance may have a number of adverse physiological consequences, the extent of which depends on the length and severity of energy restriction. These physiological effects include (Dolan, 2010; Sullivan, 2008);

- Muscle mass loss
- Reproductive dysfunction
- Bone loss or failure to reach peak bone mass
- Increased susceptibility to injury, fatigue, infection and a prolonged recovery process
- Decreased immune function
- Cardiac impairments and possible failure if extreme
- Neuroendocrine disturbances
- Gastrointestinal discomfort
- Body pains
- Electrolyte imbalances and decreased iron levels linked to reduced oxygen transport.

For maintenance or normal endocrine function, 30 kcal/kgLBM/day (126KJ/kgLBM/day) is required (Dolan, 2010). Estimated energy intake relative to lean body mass on race days has shown extremely low levels of energy availability for usual daily and metabolic processes. Race day total energy expenditure has been estimated to be 3952±577 kcal/day (16,535±2414 KJ/day) suggesting a mean race day energy availability of 0.8±12 kcal/kgLBM/day (3±50 KJ/kgLBM/day) substantially lower than 30 kcal/kgLBM/day (126 KJ) (Dolan et al., 2011).

Severe energy restriction may induce protein oxidation with the resulting loss of fat free mass and muscular strength, both detrimental to performance (Dolan, 2010). In athletes, reduced lean tissue and hence muscle mass may be more problematic than losing body fat supporting the need for careful attention to ensuring sufficient energy intake to maintain lean tissue mass (Sudi, Őttl, Payerl, Baumgartl, Tauschmann & Műller, 2004).

Chronic weight control can also impact on bone health. While bone strength may be genetically predetermined, the lifestyle, exercise and nutritional habits of jockeys may not be conducive to the development of optimal bone health with decreased bone mineral density increasing bone fragility, increasing the risk of fracture from an impact that may otherwise leave them unharmed (Warrington, McGoldrick & Griffin, 2009).

Dolan (2010) demonstrated a lower bone mass as a result of calorie restriction in both National Hunt and Flat jockeys than both age and BMI matched boxer and control groups and an assumed increase in fracture susceptibility. The osteogenic benefits associated with high impact activity in the boxer group may outweigh the benefits associated with lean mass alone, having a protective effect. Horse riding has been suggested to convey low gravitational forces to jockeys that may not provide strong enough osteogenic signals to the body (Dolan, 2010).

Warrington et al. (2009) found osteopenia in one or more of the hip, lumbar spine or whole body scans in 59% of flat jockeys and 40% of national hunt jockeys, comparable to Leydon & Wall (2002) who found oseopenia in 44% of New Zealand jockeys studied.

National hunt jockeys have been found to have a significantly higher whole-body bone mineral density than flat jockeys thought to be due to the differences in weight ranges allowing national hunt jockeys to be less restrictive in their diets due to higher riding weights. However, studies have shown no significant difference in the weight loss habits of flat and national hunt jockeys due to flat jockeys tending to be naturally lighter and shorter in stature (Dolan et al., 2011; Warrington et al., 2009)

RMR appears to be disproportionately reduced when in a state of energy deficiency and in periods of prolonged underfeeding, may be followed by a rapid and disproportionately high replenishment of body adipose tissue stores, this is likely due to an accelerated rate of *de noro* lipogenesis and an increase in *ad libitum* fat intake (Dolan, 2010). Higher body fat levels have been shown in energy deficient runners in contrast to a group of their energy replete counterparts.

Prolonged energy restriction or periods of weight cycling such as following an injury may enhance food efficiency due to a disproportionate reduction in RMR as the body tries to maintain energy balance under extreme conditions (Dolan, 2010). Calorie restriction is associated with robust decreases in energy metabolism as in addition to reducing RMR there is also a reduced thermic effect of meals due to fewer calories being consumed and a decrease in the energy cost of physical activity due to a reduced body mass. It is also possible that the level of physical activity may be reduced due to the lack of energy availability (Redman, Heilbronn, Martin, de Jonge, Williamson, Delany & Ravussin, 2009).

Behaviourally, a response to semi starvation conditions has been found to be a tremendous decrease in physical activity in overweight individuals, perhaps due to increased fatigue. Redman et al. (2009) estimated that reduced physical activity accounted for 58% of the decreased total energy expenditure of participants whereas a reduction in RMR accounted for 32% and the reduced thermic effect of food, only 10%.

Redman et al. (2009) found a 6% reduction in RMR beyond what was expected for the loss of metabolic mass when measured both in a respiratory chamber and by a ventilated hood indirect calorimeter. Daee, Robinson, Lawson, Turpin, Gregory and Tobias (2002) also reported a reduction in RMR exceeding that accounted for by changes in lean body mass by 15% in obese participants. Although a portion of the reduction in RMR was due to a reduction in the thermic energy of food and reduced energy cost of spontaneous physical activity, as the energy cost of physical activity is proportional to body weight, the majority was due to the smaller size of the metabolising mass and a lowering of the rate of metabolism per mass unit of tissues and organs (Redman et al., 2009).

Following calorie restriction, the state of energy restriction alters abruptly to a negative imbalance which eventually reaches a new equilibrium at a lower body mass when the decline in energy expenditure is matched by the equivalent energy intake. This physiological adaptation may contribute to protection against excessive weight loss during caloric restriction but may predispose post-obese individuals to weight re-gain. Exercise combined with calorie restriction protects against these metabolic adaptations whilst inducing similar changes in body composition to calorie restriction alone (Redman et al., 2009). The negative consequences of this for jockeys is that further weight loss and maintenance may become progressively more challenging (Dolan, 2010).

Other studies have found no long term metabolic changes in healthy female rowers with a history of weight fluctuations and dieting. Weight cyclic rowers (n=7) lost 4.2±1.8 kg in their peak season, regaining 4.0±2.1 kg in their off-season, differing significantly from the control group (n=7) (P=0.03) who maintained a stable body mass. However, RMR and triiodothyronine levels changed with time in both groups (P=0.01; P=0.00 respectively) and this appeared to reflect changes in fat free mass and not in bodyweight (McCargar, Simmons, Craton, Tainton & Birmingham, 1993).

The findings of Muls, Kempen, Vansant and Saris (1995) are in agreement with this despite both studies being small. A cross-sectional study in wrestlers observed an association between weight cycling and reduced resting energy expenditure similar to that seen in non-obese women. However subsequent studies in non-obese and obese men and women failed to find an association between weight cycling history and metabolic rate in agreement with the aforementioned study (Muls et al., 1995).

Long-term dieting affects body composition, increases the risk of cardiovascular disease and leads to endocrine abnormalities associated with reproductive function (Sudi et al., 2004). In female athletes, low energy availability can cause disruption to reproductive function and bone loss known as 'the female athlete triad' caused by the body's attempts to conserve energy for the maintenance of more immediate and essential processes (Dolan, 2010).

The extent of the negative consequences of inadequate energy intake is dependent upon an interaction between environmental and genetic influences and whilst many weight category athletes are able to minimise the negative effects on performance by refuelling adequately in the time between weighing in and competition, this luxury is not afforded to jockeys (Dolan, 2010).

With respect to starvation and the induced depletion of fat stores and alterations of circulating adipocytokines, there may be several differences in the regulation of the endocrine system across sports. The training and eating schedules of ski jumpers for example differ substantially from athletes participating in sports with a high metabolic demand such as road cycling and endurance running. Despite the leanness of these athletes and their hypophagic status during certain training periods, ski jumpers rely soley on a low-calorie diet to reach a competitive body weight, whereas athletes with a high metabolic demand can reduce body mass and fatness by increasing their training volume and intensity whilst maintaining their energy intake. The resulting changes in body mass due to dieting and training are reflected by different changes in the hormonal status throughout the preparation period and competitive season (Sudi et al., 2004).

2.5.1.2 Psychological effects of energy restriction in jockeys

The use of sports psychology in horseracing remains very limited (Caulfield & Karageorghis, 2008). A successful mood profile in sports research for athletes has been defined as the 'iceberg' profile characterised by reporting scores for vigour above the 50th percentile and scores for anger tension, depression, fatigue and confusion below the 50th percentile of published norms (Degoutte et al., 2006). Energy restriction has been found to modify this psychological profile in judo athletes. Weight loss resulted in reduced scores for the positive mood state vigour and increased scores for the negative mood states tension, anger, fatigue and confusion, a pattern also seen in athletes who overtrain (Degoutte et al., 2004; Filaire et al., 2001; Terry et al., 1999). These results agree with those of Koral & Dosseville (2009) where a rapid reduction in bodyweight in judo athletes increased tension, fatigue and anger whilst decreasing vigour.

It has been proposed that positive emotional health and successful athletic performance are correlated (Koral & Dosseville, 2009). The Minnesota Semi Starvation study indicated that calorie restriction can negatively affect mood and therefore may impact negatively on an individual's quality of life (Redman et al., 2008).

Terry and Slade (1995) classified winners and losers in karate according to their pre-performance mood profiles and found that winners scored highly for anger, which in percussion combat sports such as karate and boxing may be advantageous (as reported by Koral & Dosseville, 2009). It is also thought that an increase in tension could motivate athletes when experienced independently from depression (Koral & Dosseville, 2009).

It is possible that the mood state displayed by athletes prior to competition reflects the pre competitive status of the athlete (Degoutte et al., 2004). A jockey's mood state is likely to be linked to the race, the previous race, the horse they are riding and their chances of success. Pre-competition mood has been found to be an effective predictor of a single performance (Degoutte et al., 2004).

Significant differences have been found in male professional flat and national hunt jockeys (30.87±7.01 years) between mood responses, eating attitudes and behaviour at their lightest weight, optimal weight and relaxed weight with the differences most evident between the lightest and relaxed weights (Caulfield, Karageorghis, Terry and Chatzisarantis, 2003). Situations requiring rapid weight loss impacted negatively on mood responses, significantly anger, depression, vigour ($P<0.001$), confusion and tension ($P<0.05$). At jockeys' lowest weight the eating attitudes were more negative than at the other two although the mean EAT (Eating Attitudes Test) score (8.56) did not reach the threshold level of 20 associated with eating disorders, 15% (n=6) scored higher than 20 indicating an increased risk of eating disorders. These EAT scores are lower than those previously reported by Leydon and Wall (2002) of 13.5 and King and Mezey (1987) of 14.9 possibly due to the small sample sizes in these studies (16 and 20 respectively) (Caulfied & Karageorghis, 2008).

The authors concluded that jockeys appear to accept the need for strict weight management routines during competition significantly more than when they are out of competition indicating a possible awareness of the potentially deleterious behaviours associated with repeated weight cycling. Jockeys may potentially limit the negative effects of wasting behaviours with a more relaxed attitude to weight control during non-racing periods (Caulfied et al., 2003).

A history of weight cycling has not been found to be associated with depression or cognitive dysfunction but there is a possibility that repeated dieting may predispose an individual to increasingly disordered eating including binge eating although this remains unconfirmed (Muls et al., 1995).

A randomised control trial by Martin et al. (2007) found that calorie restriction marked by significant weight loss and quantification of average daily energy deficit from change in energy stores, was not associated with a consistent pattern of deficits in verbal memory, visual memory or attention or concentration performance. These findings suggest that it is the self-reported dieters increased preoccupation with food and their body size and shape that is associated with negative cognitive functions and not the calorie restriction itself as high restraint dieters have been found to have the worst performance on cognitive tests (Martin et al., 2007; Redman et al., 2008).

2.5.2 Dehydration

Quantitatively water has been defined as the most important nutrient in the body comprising approximately 63% of total body mass and 80-84% of kidney, lung and skeletal muscle tissue (Dolan, 2010). Dehydration occurs when inadequate water is available to maintain required water levels within the body tissue and systems (Sullivan, 2008). Hydration status and cell size appear to be involved in cellular metabolism with excessive alterations in cell volume potentially compromising structural integrity and metabolic function. It is suggested that cellular shrinkage occuring during dehydration may induce a catabolic state (Dolan, 2010).

Dehydration occurs frequently during physical activity because humans rarely ingest enough water during exercise to match the amount lost in sweat and dehydration often contributes to hyperthermia by reducing the body's capacity for heat loss (Murray, 1996). Athletes engaging in short-term weight loss practices such as sauna use and exercise in a sweat suit are at high risk of dehydration and the associated physical consequences, in extreme cases, of heart failure or death (Sullivan, 2008).

Excessive dehydration has been linked to the deaths of three American collegiate wrestlers and excessive weight control and dehydration were cited as the possible reasons for the deaths of two young jockeys in America, one collapsed after a race due to severe dehydration, the other suffered a fatal heart arrhythmia caused by a potassium deficiency as a result of chronic weight control and energy restriction (Dolan et al., 2011).

Dehydration is known to impact on both physiological and cognitive function and to be detrimental to performance. Acute weight loss strategies are likely to contribute to high levels of dehydration (Dolan et al., 2011). Unfortunately a major limitation of many studies into the effects of dehydration is the inability to determine the effects of dehydration independent of the effects of thermal stress, physical stress and/or fatigue (Grandjean & Grandjean, 2007).

2.5.2.1 Physiological effects of dehydration on jockeys

Hydration status plays a vital role in aerobic exercise and sports performance, initiation of exercise in a dehydrated state will impact on performance (see Table 4). Exercise represents a physiological strain on the body which increases metabolic rate and blood transportation requirements (Dolan, 2010). Jockeys may be particularly fearful of water ingestion as 100ml of water ingested equates to 100g of weight (Sullivan, 2008). Respiratory exchange ratio has found to be reduced and substance use shifted from carbohydrate to lipid sources suggesting a reliance on lipid metabolism when exercising in a dehydrated state (Dolan, 2010).

Reduced plasma volume as a result of water loss and increased glycogen utilisation appear to be involved in performance decrements as a result of dehydration but are not the primary limiting factor. Performance decrements occur at a dehydration threshold of 2% body mass loss (Dolan, 2010). The detrimental effects of dehydration on aerobic exercise include a reduced physical capacity and enhanced physiological strain (see Table 4).

Mild dehydration of approximately 1.5% body mass induced through exercising in a sweat suit and restricted fluid intake caused a shift in lactate threshold towards a lower percentage of VO_2 max and therefore a significant reduction in time to exhaustion in a group of moderately active healthy females (see Table 4) (Dolan, 2010). Strength and power appear to be affected less by the effects of dehydration. The dehydration threshold needed to induce impairments in shorter duration, aerobically independent exercise may be greater than 2% (Dolan, 2010).

The thirst mechanism is triggered at a serum osmolality of approximately 290 mOsml/kg. It is unusual to attain such values as the thirst sensation may prove too difficult to override but extremely high levels have been reported amongst jockeys, indicating that habituation to dehydration may have lead to an impairment of the thirst mechanism in this group. It is however unlikely that humans can habituate to tolerate the physiological and cognitive impairments associated with such severe dehydration and this is likely to have negative impacts on cognitive and physiological function (Warrington et al., 2009).

Table 4-The negative physiological consequences of dehydration and their effects (Dolan, 2010).

Physiological Consequence	**Effect**
Reduced stroke volume and muscle blood flow	Limits blood flow and increases cardiovascular strain
Inhibited glycogen and protein synthesis	Reduces substrate supply and increases fatigue
Possibly increases glycogen utilisation rate during exercise	Diminishes an already limited substrate supply and increases fatigue
Increases heart rate and lactate levels	Increases fatigue and cardiovascular strain
Cell shrinkage and reduced plasma volume	Impairs thermoregulation ability increasing the risk of heat related illnesses
A reduction of lactate threshold to an earlier time	Reduced time to fatigue
A lower absolute VO_2	Reduced time to exhaustion
An increase in rate of lactate accumulation	Reduced time to fatigue

Excessive use of saunas has been associated with a range of negative health outcomes. Many jockeys rely on saunas for rapid weight loss and all racecourses now have a sauna installed (Caulfield & Karageorghis, 2008).

In a sample of 14 eating disorder patients sauna abuse was linked to (Caulfield & Karageorghis, 2008);

- Fluid, electrolyte and acid-base imbalance
- Abnormally low blood pressure
- Hyperventilation
- Increased blood alkalinity
- Hypertension

Most jockeys appear to be habitually dehydrated on non-race days and to an even greater extent on race days (Sullivan, 2008). Urine specific gravity tests have revealed moderate dehydration amongst jockeys on non-race days (Usg=1.022±0.005 and Usg=1.021±0.007 for flat and national hunt jockeys respectively). Analysis of 11 flat jockeys revealed marked dehydration on an official race day (Usg=1.028±0.005) (Warrington et al., 2009).

Marked dehydration has been found amongst jockeys studied on race days (n=14), 93% had high to severe levels of dehydration (Warrington et al., 2008) due to the need to maintain their weight throughout the race, there is no opportunity to rehydrate prior to the event unlike in many other weight controlled sports (Sullivan, 2008).

Despite the detrimental physiological effects of dehydration, highly trained and more successful marathon runners often complete races in dehydrated states of 4-8%. It is likely that the reduced body mass as a result of fluid loss may lower the energy cost of running, potentially offsetting the detrimental effects of dehydration (Dolan, 2010). Maximal hill cycling performance however is compromised when initiated in a dehydrated state despite a significant reduction in power output as a result of reduced body mass (Dolan, 2010).

During high intensity exercise a well-trained athlete has a twenty-fold increase in heat metabolism. If regularly experiencing heat stress, most athletes develop a higher heat tolerance than people who exercise little. Despite this however a drop in hydration levels of more than 3% of body weight is a significant risk factor for heat illness and therefore must be closely monitored (Sullivan, 2008).

Certain amounts of dehydration are tolerable to the human body. If allowed to drink *ad libitum* human beings are capable of maintaining plasma osmolality within physiological limits, if not body mass (Dolan, 2010). Although athletes may learn to cope with the physical discomfort associated with dehydration, there is no evidence to support a physiological adaptation to this stressor. It is likely that dehydration to lose body mass in jockeys may affect performance as well as representing a significant health and safety concern to the horseracing industry (Dolan, 2010).

2.5.2.2 Psychological effects of dehydration on jockeys

Dehydration has been shown to have a number of negative psychological effects on performance in athletes. Impaired mental attention and increased subjective feelings of fatigue may contribute to performance decrements as a result of dehydration (Dolan, 2010). In severe cases dehydration can result in delirium and coma but many aspects of cognitive function are impaired before this critical state is reached (Dolan, 2010).

Hypernatremia resulting from dehydration causes cell shrinkage and cellular dehydration and manifests in central nervous system depression, reduced mental status, confusion, abnormal speech and stupor or coma in the extreme (Dolan, 2010). Development of voluntary hypernatremia is rare as the body's thirst response is a strong reactive mechanism however this is not triggered until body water loss reaches 2%, a level at which performance detriments are typically noted. Hypernatremia has been reported in a group of jockeys on race days (Warrington et al., 2009).

A reduced plasma volume due to dehydration may additionally cause a decrease in blood flow through the brain possibly contributing to the observed negative effects on cognitive functioning. Other research has disproved this theory as brain cell volume has shown to be unchanged in dehydrated rats with water being lost mainly from skeletal muscle (Dolan, 2010).

Some aspects of cognitive function appear to be impaired by levels of dehydration similar to that at which physical impairments are seen, levels resulting in a 2-3% reduction in body mass. Dehydration levels of 1% may adversely affect cognitive performance when a 2% or more reduction in body weight is induced by heat and exercise exposure resulting in reduced visual-motor tracking, short-term memory and attention (Lieberman, 2007). Simpler aspects of cognitive function appear to be more robust to the effects of dehydration as it tends to affect these more complex cognitive processes (Dolan, 2010).

The brain areas most vulnerable to dehydration include;

- Reticular activating systems controlling attention and wakefulness, a particular problem for jockeys who may have to drive a number of miles each day to race meetings.
- Autonomic structures regulating psychomotor and regulatory function
- Cortical and mid brain structure responsible for thought, memory and perception all detrimental to performance in a race (Dolan, 2010).

Dolan (2010) did not find cognitive function in jockeys to be affected by rapid dehydration over 48 hours. These findings are in agreement with those of Szinnai, Schachinger, Arnaud, Linder and Keller (2005) who also found no significant change to cognitive function ($P>0.1$) in young, healthy men and women ($n=16$; 26yrs). This study differed in the experimental protocol in that moderate dehydration was induced slowly and progressively by water deprivation over a 24 hour period and not rapidly over a 48 hour period.

Despite this, subjective ratings of mental performance changed significantly towards increased tiredness and reduced alertness ($P<0.05$) and levels of perceived effort and concentration increased ($P<0.05$). Healthy individuals may exhibit cognitive compensating mechanisms for increasing tiredness and decreasing alertness during slowly progressive moderate dehydration (Szinnai et al., 2005). A gender effect was noted as reaction time increased in women but decreased in men following dehydration. Cognitive-motor function may be preserved during water deprivation in young humans up to moderate dehydration levels of 2.6% bodyweight (Szinnai et al., 2005).

Cian, Berraud, Melin and Raphel (2001) found dehydration up to 2.8% bodyweight loss impaired cognitive abilities such as perceptive discrimination and short-term memory, as well as subjective estimates of fatigue 30 minutes after the dehydration was induced either through passive exposure to heat or treadmill exercise in healthy men. By 3.5 hours following fluid deficit dehydration, cognitive function had normalised despite subjects feeling increasingly tired. These studies suggest that it may not be the dehydration *per se* that is the limiting factor in cognitive performance but the methods used to induce dehydration that contribute to observed decrements (Dolan, 2010).

2.6 Weight management and eating disorders in athletes

Generally, studies suggest an increased frequency of eating disorders in athletes than in non-athletes especially in sports emphasising leanness or a low body weight (Byrne & McLean, 2001). Eating disorders are most prevalent in sports requiring leanness such as endurance running, aesthetic sports such as gymnastics and ballet and weight category sports such as wrestling, horse racing and lightweight rowing (Baum, 2006; Bryne & McLean, 2001; Sundgot-Borgen & Torstveit, 2004; Yates et al., 2003).

Estimates of the prevalence and symptoms of eating disorders vary due to the wide variation of athletic populations studied, the level of sporting proficiency of the athletes and the methods of measuring eating problems (Byrne & McLean, 2001). Athletes are subjected to increased sociocultural pressure to conform to an ideal body shape in addition to specific pressure from within their sport to improve their physique and therefore performance (Byrne & McLean, 2001).

The very nature of an athlete and the psychological makeup of elite athletes; perfectionism, high levels of goal orientation, competitiveness and an intense concentration on performance, may in fact make athletes more vulnerable to developing eating disorders (Byrne & McLean, 2001; Sundgot-Borgen & Torstveit, 2004; Yates, Edman, Crago & Crowell, 2003). Conversely, Baum (2006) theorised that involvement in sport and physical activity could protect athletes from developing eating disorders as increased physical activity may promote a healthier lifestyle and attitude towards food and eating, perhaps fostering a food-as-fuel motif.

It is generally accepted that female athletes suffer from more eating disorders than males (Baum, 2006; Beals & Manore, 1998; Bryne & McLean, 2001; Sundgot-Borgen & Torstveit, 2004; Yates et al., 2003). A significant stigma exists around psychiatric illness in the athletic arena and perhaps more so amongst the male athlete (Baum, 2006). As a group, athletes are likely to deny anything that could be construed as a weakness (Yates et al., 2003) and may fear that discovery of an eating disorder may adversely affect their career prospects or sponsorship deals (Sundgot-Borgen & Torstveit, 2004). There is a potential for underreporting among athletes who fear that discovery of an eating disorder may have a negative effect on their career (Baum, 2006; Byrne & McLean, 2001; Sundgot-Borgen & Torstveit, 2004). Over reporting could be expected from athletes looking for a reason to quit the sport (Sundgot-Borgen & Torstveit, 2004).

A large two-step study involving the entire population of Norwegian elite athletes and a representative control group from the Norwegian general population found significantly more athletes than controls suffered from subclinical or clinical eating disorders (13.5% and 4.6% respectively, $P<0.001$) (Sundgot-Borgen & Torstveit, 2004).

Athletes competing in weight class sports had a high prevalence of eating disorders, reflecting the fact that many of the athletes aim for a low body fat mass and high body muscle mass in order to compete in weight categories below their ordinary weight (Sundgot-Borgen & Torstveit, 2004). Terry et al. (1999) found higher scores on the Eating Attitudes Test (EAT) among a group of elite lightweight rowers when compared to their heavyweight counterparts. 12% also reported scores above the threshold associated with eating disorders.

Body shape concerns as assessed by the Body Shape Questionnaire (BSQ) however were higher for heavyweights than lightweights and for females than males. A high percentage of weight class athletes use extreme weight control methods early in their career, putting them at increased risk of developing an eating disorder and affecting their long-term health (Sundgot-Borgen & Torstveit, 2004).

A*norexia athletica* allows the identification of athletes displaying some but not all of the symptoms of an eating disorder, notably a fear of gaining weight or getting fat despite being underweight (at least 5% less than the expected normal weight for their age and height when compared to the general population). Sufferers may display evidence of some of the psychologic traits associated with clinical eating disorders such as high achievement orientation, obsessive compulsive tendencies and perfectionism. The reduction in body mass in *anorexia athletica* sufferers is based solely on performance and not on appearance or excessive concern about body shape (Sundgot-Borgen & Torstveit, 2004) but many athletes will have lower than expected body weights and body fat percentages regardless of *anorexia athletica* (Sudi et al., 2004)..

2.6.1 Eating disorders in jockeys

The weight requirements of jockeys increase the risk of developing or sustaining eating disorders (Baum, 2006). Male jockeys are considered to be more at risk than females due to women being naturally lighter and smaller and therefore more able to achieve the same weight goals as male jockeys (Baum, 2006).

The goal of weight loss can be an infectious or epidemic phenomenon outside the elite levels of competition and perhaps even outside the sport itself as prominent athletes frequently become role models (Baum, 2006). Athletes required to make weight face a tendency to revert to their increasingly entrenched patterns of eating and disordered behaviour even outside the context of their sport. Abnormal practices and preoccupation with weight and body image can become routine and incorporate themselves into an athlete's psyche and strategies for coping with life in general, this can become a lifelong difficulty for jockeys (Baum, 2006).

A negative correlation was found between a self-loathing subscale (SLSS) and exercise investment, indicating that athletes high on the SLSS invested more into dieting than exercise which may have become the secondary interest. In this respect these athletes resemble eating disorder sufferers as exercise is undertaken solely for weight loss purposes. This could be true of jockeys trying to make weight (Yates et al., 2003).

A lack of education and training given to jockeys often as young as sixteen, at the start of their career could be an influencing factor. There is concern about the effects of unhealthy practices among growing developing adolescents (Baum, 2006). Eating disorders typically begin during adolescence and early adulthood and the onset of puberty causes rapid changes in body shape which may be of particular significance, especially for females and can be a cause of concern for young jockeys claiming a weight allowance. It is not uncommon for young flat jockeys to become jump jockeys as a result of becoming too tall and heavy to make the weight on the flat (Byrne & McLean, 2001).

A team effect has been identified amongst athletes regarding disordered eating and unhealthy weight loss practices. All racecourses now have saunas installed and it is possible that there may be a camaraderie or ritual effect surrounding jockeys and sauna use (Baum, 2006). In additional there is a financial incentive for jockeys to be able to ride at low weights at short notice to increase the number of possible rides (Dolan et al., 2011).

Jockeys commonly report disordered eating and weight control behaviours such as food avoidance, sauna use, and abuse of laxatives, diuretics and appetite suppressants. Bingeing has been shown to be common although unusually self-induced vomiting uncommon (King & Mezey, 1987).

Baum (2006) reported a 1995 study by Christine (1995) in which;

- 69% of jockeys skipped meals
- 67% used a sauna
- 30% self-induced vomiting
- 14% regular laxative use

Many jockeys could be regarded as *anorexia athletica* sufferers due to frequently engaging in extreme weight loss behaviours such as food avoidance, sauna use and abuse of laxatives or diuretics (King & Mezey, 1987; Sundgot-Borgen &Torstveit, 2004).

Despite this an early study found that the weight making practices and disordered eating habits of jockeys do not necessarily increase the risk of development of clinical eating disorders characterised by severe psychological disturbances in addition to disordered eating patterns (King & Mezey, 1987). While psychologically athletes engaging in extreme weight loss practices appear to not to be at an increased risk of developing an eating disorder, physiologically they are still placing their health at a major risk (Dolan, 2010). More recent research has found evidence of negative mood states and disordered eating attitudes when riding at a jockey's minimum weight suggesting that the psychological well being of jockeys may be at risk as a result of their weight making practices (Caulfield & Karageorghis, 2008).

CHAPTER 3

METHODOLOGY

3.0 Method

3.1 Participants

In the 2008-2009 season, 527 jockeys held a license (Horseracing Betting Levy Board, 2009). The sample comprises Flat and National Hunt jockeys currently riding in the UK. For this study 47 participants were recruited at Bangor-on-Dee and Chester race meetings (29 National Hunt, 12 Flat and 6 Dual Purpose) with the help of Jeannie Chantler, manager of these racecourses (See Appendix A).

The inclusion criteria included;

- Jockeys must have been aged between 16 and 50 years of age
- Jockeys must have held a current license to ride under the rules of the British Horseracing Board (BHB).
- Amateur riders must have held a category A or B license.
- Jockeys must have been currently riding in the UK.

The study consisted of 29 National Hunt Jockeys (26 male, 3female; median age 23.5 yrs), 12 Flat jockeys (12 male; median age 23.5 yrs) and 6 Dual Purpose jockeys (5 male; 1 female; median age 18.5 yrs).

3.2 Experimental Design

Participants were invited to complete a 27 item questionnaire (see Appendix B) at their convenience during race meetings at Bangor-on-Dee racecourse on 29th August 2011 and Chester racecourse on 10th September 2011. The questionnaire was distributed, complete with a pen, with the help of the manager of each racecourse due to the restraints on access to the jockeys weighing and changing rooms. Detailed instructions on how to complete the questionnaire were provided and the researcher was available in a designated area to answer any questions that the participants may have had regarding completion of the questionnaire. On completion of the questionnaire, participants were instructed to place them into a designated box in the weighing room. The box of completed questionnaires was returned to the researcher via the manager at the end of the day's racing.

3.2.1 The Questionnaire

The 27 item questionnaire consisted of 2 sections and took participants approximately 10 minutes to complete (see Appendix B). The questions were developed specifically for the current study based on previous research on jockeys and other weight categorised sports and collected information on general health, smoking, methods and time frames of weight control for racing and the perceived negative effects associated with making weight and habitual sensations of hunger and thirst experienced (Oppliger et al., 2003; Sullivan, 2008). The first section focuses on the jockey's personal and career information and the second section on the methods, frequency and effects of weight management.

3.3 Data Analysis

The data was analysed using SPSS software. The data was primarily nominal, ordinal and ratio data. Data analysis initially included descriptive statistics to determine mean and standard deviation, mode, median and range values focusing on the frequency of jockeys weight loss behaviour and the perceived impact on physical and psychological health and wellbeing.

For parametric data of identical variances, independent t-tests were performed to describe the differences between personal and career data of Flat, Dual Purpose and National Hunt jockeys. For non-parametric data that did not satisfy these assumptions, a Mann-Whitney U test was performed (Williams & Wragg, 2004).

For non-parametric, ordinal data involving the jockey's ranked, perceived negative effects, Spearman's rank correlations helped to identify the relationships between weight loss variables and the jockey's perceived physiological and psychological effects of weight management (Williams & Wragg, 2004). Kruskal-Wallis ANOVA (ordinal 3 or more independent groups between subjects) and post hoc analysis was performed to test differences for non-parametric data between variables and between Flat, Dual Purpose and National Hunt jockeys (Williams & Wragg, 2004). Descriptive statistics and frequency analyses were used to analyse a number of close-ended questions non-parametric statistics and mode and median scores were employed for Likert type questions.

CHAPTER 4

RESULTS

4.0 Results

4.1 Personal and career information

A total number of 47 jockeys took part in the study, of these one had recently retired resulting in a total of 46 jockeys that held a current license (43 male and 3 female; median age 23.5 yrs). 14 professional jockeys (30%), 19 conditional or apprentice jockeys (41%) and 14 amateur jockeys (30%). Of these 29 were National Hunt jockeys (63%), 12 Flat jockeys (26%) and 5 Dual Purpose (11%). Of these 3 were currently not riding but did hold a license.

An independent t-test identified a significant difference in mean height of National Hunt and flat jockeys with National Hunt jockeys taller than flat jockeys 0.86 (95%CI 0.20 to 0.11), $p=0.006$. A Mann-Whitney U test found no significant difference in jockey heights between flat (median 1.65m) and dual purpose jockeys (median 1.68m) $U=44.5$, $z=1.596$, $p=0.110$ and dual purpose (median 1.68m) and National Hunt jockeys (median 1.72m) $U=54.5$, $z=-0.891$, $p=0.373$ (see Table 5) (see Appendices C and E) .

National Hunt jockeys were found to be significantly heavier than both Flat ($P=0.000$) and Dual Purpose ($P=0.001$) jockeys at their approximate non-racing weight. Dual Purpose jockeys were also found to be significantly heavier than Flat jockeys at their approximate non-racing weight ($P=0.008$). At their lowest riding weights, National Hunt jockeys were significantly heavier than both Flat ($P=0.000$) and Dual Purpose jockeys ($P=0.004$) and Dual Purpose jockeys were significantly heavier than Flat jockeys at their lowest racing weight ($P=0.002$) (see Table 5) (see Appendices E, F and G).

Table 5 - Anthropometric characteristics of National Hunt, Flat and Dual Purpose Jockeys (mean±standard deviation)

	Total *(n=46)* 43 Male;3 Female	National Hunt *(n=29)* 26 Male;3 Female	Flat *(n=12)* 12 Male	Dual Purpose *(n=5)* 5 Male
Median Age (yrs)	23.5	23.5	23.5	18.5
Height (m)	1.72±0.07	1.76±0.05	1.64±0.05	1.70±0.06
Non-racing Weight (kg)	60.0±6.3	63.5±4.29	53.1±5.5	57.5±0.21
Non-racing BMI (kg/m^2)	19.9±3.45	20.6±1.68	19.8±2.14	20.0±1.24
Lightest Racing Weight (kg)	57.9±5.0	60.8±3.26	51.3±2.12	56.9±2.44
Lightest BMI (kg/m^2)	19.7±1.36	19.8±1.31	19.1±1.42	19.8±0.98

Mann-Whitney U tests identified no significant differences between the approximate non-racing weight and lowest racing weight of Dual Purpose or Flat jockeys (P=0.589 and P=0.433 respectively). A significant difference was found between the approximate non-racing weight and lowest racing weight of National Hunt jockeys (P=0.000) (see Figure 2) (see Appendix H).

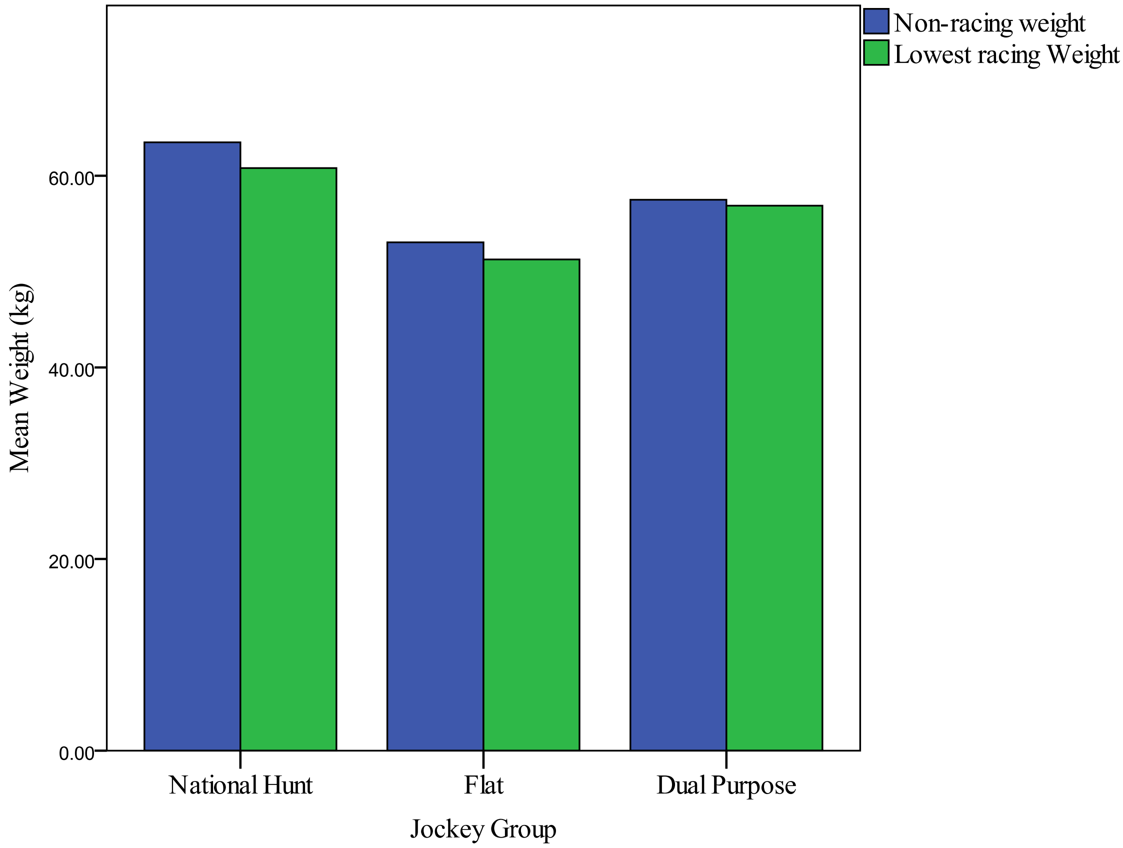

Figure 2 - A graph to show the difference between approximate non-riding weight and jockeys lowest riding weight for different groups of jockeys (* denotes significant difference).

Of the total group, participants had been race riding for approximately 5.8±4.82 years and had 6.0±5.15 rides in races per week. A Kruskal-Wallis test did not identify any significant differences between jockey types for riding career (P=0.061) or rides per week (P=0.135) (see Table 6) (see Appendix I).

Table 6 - Jockeys career information (mean±standard deviation)

	Total	National Hunt	Flat	Dual Purpose
Riding Career (yrs)	5.8±4.82	5.2±3.41	8.8±7.01	2.7±1.9
Rides per week	6.0±5.15	5.4±3.62	8.8±7.53	3±2.9

4.2 Lifestyle and weight control

68% of jockeys reported experiencing some difficulty in managing their weight (see Figure 3) with 49% indicating that they usually have to lose weight to make their riding weight. 39% had had to lose an average of 3-4 lbs during the last seven days to make a riding weight with jockeys indicating that they lost approximately 1.9±2.9 lbs for their last race over a period of 1±1.5 days. Despite this 77% indicated trying to maintain a low weight rather than relying on rapid weight loss. The majority (70%) had never ridden overweight. The majority of jockeys (74%) had not consulted a nutritionist in the past regarding managing their weight.

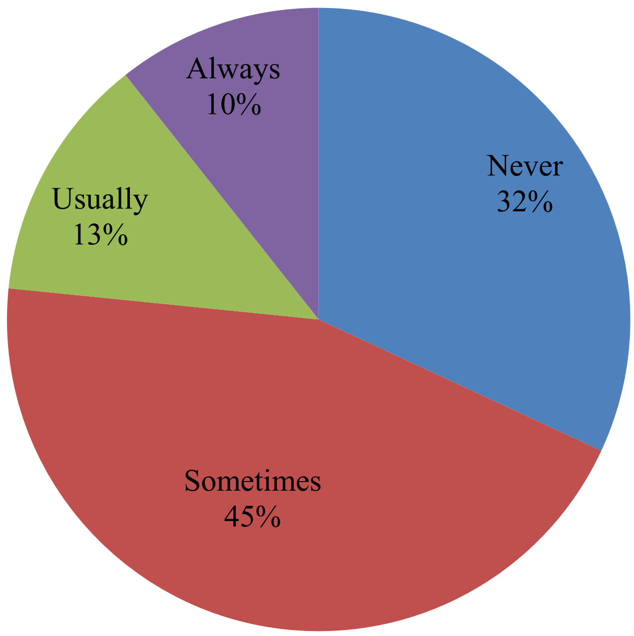

Figure 3 - A graph to show the percentage of jockeys experiencing difficulty managing their weight

Jockeys indicated participating in a number of different weight control methods (see Table 8) and spent 5±2.87 hours doing additional exercise per week. With regards to their diet, jockeys indicated that being too tired to cook and eating what is readily available affected their food choices most frequently although there were no significant differences between the jockeys' reasons for making their food choices (see Appendix J). Average daily diet data indicated that only 30% of participants included vegetables in their diet and only 18% included fruit. 48% regularly consumed chocolate, sweets or biscuits and 50% drank tea or coffee regularly (see Appendix D). Jockeys consumed 5±8.28 units of alcohol per week.

4.3 Hydration and weight control

Jockeys engaged in a number of different methods to actively dehydrate. In addition to 64% indicating that they restricted their fluid intake, jockeys spent an average of 3.2±2.73 hours a week in sweating sessions (see Table 7). In addition, 12% of jockeys indicated that they never eat or drink before a race, of those that did eat or drink they did so an average of 1.6±1.26 hours prior to the race

Table 7 - The mean weekly duration and type of sweating session participated in by jockeys.

Type of sweating session	Mean duration (hrs)
Sauna	1.56±1.85
Bath	0.92±1.58
Exercise in a sweat suit	0.85±1.55
Other	0.40±1.64

All participants engaged in a number of weight control methods prior to, or on race days, most notably 74% of the total participants engaged in food restriction, 64% in fluid restriction, 78% sauna, 96% riding exercise and 98% other exercise (see Table 8).

Table 8 - The percentage of jockeys engaging in different weight control methods

Method	Total $n=46$
Food Restriction	74
Fluid Restriction	64
Sauna	78
Laxatives	6
Appetite Suppressants	0
Riding Exercise	96
Other Exercise	98
Exercise in hot environment	41
Sweat suit exercise	59
Hot salt bath	61
Smoking cigarettes	37

Participants rated the occasions on which they engaged in a number of weight control methods (Likert scale: 1 = Never, 2 = Between race days, 3 = Day before race days, 4 = On race day, 5 = Daily). Table 9 shows the mode responses. No significant differences were found between each of the jockey types for any of the weight control methods tested (see Table 10) (see Appendix K).

Table 9 – The mode responses for the occasions when jockeys use different weight control methods

Method	Total	National Hunt	Flat	Dual Purpose
Food Restriction	Never	Day before race day	Daily	Never
Fluid Restriction	Never	Never	Daily	Never
Sauna	On race days	On race days	Daily	Never
Laxatives	Never	Never	Never	Never
Appetite Suppressants	Never	Never	Never	Never
Riding Exercise	Daily	Daily	Daily	Daily
Other Exercise	Daily	Daily	Daily	Between race days
Exercise in a Hot Environment	Never	Never	Never	Never
Sweat Suit Exercise	Never	Never	Never	Never
Hot Salt Bath	Never	Day before race day	On race days	Never
Smoking	Never	Never	Never	Never

Table 10 - A comparison of the percentage of different jockey types engaging in different weight control methods

Method	National Hunt *n=29*	Flat *n=12*	Dual Purpose *n=5*	P value
Food Restriction	75	80	40	0.239
Fluid Restriction	59	81	40	0.238
Sauna	82	83	60	0.181
Laxatives	8	10	0	0.641
Appetite Suppressants	0	0	0	0.302
Riding Exercise	97	100	100	0.168
Other Exercise	100	100	100	0.232
Exercise in hot environment	50	30	40	0.797
Sweat suit exercise	63	63	60	0.857
Hot salt bath	65	67	40	0.537
Smoking cigarettes	35	44	20	0.899

4.4 Physiological and psychological effects of weight control

Jockeys reported experiencing a number of different negative physiological and psychological effects associated with weight control (see Tables 11, 12 and 13). Participants rated the frequency of experiencing a number of physiological and psychological effects associated with weight control (Likert scale: 1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Often, 5 = Daily). Table 11 shows the mode response for a number of physiological and psychological effects associated with weight loss.

Table 11-Median response for the frequency of experiencing different physiological and psychological symptoms

Physiological Symptom	Median Response	Psychological Symptom	Median Response
Muscle Cramps	Rarely	Persistent Thirst	Sometimes
Nausea	Never	Persistent Hunger	Sometimes
Fever	Never	Short Term Memory Loss	Never
Dizziness	Rarely	Long Term Memory Loss	Never
Fainting	Never	Mood Swings	Sometimes
Stomach Cramps	Never	Depression	Rarely
Poor Circulation	Never	Anxiety	Never
Fatigue	Sometimes	Irritability/Anger	Sometimes
Visual Distortion	Never	Sleep Disturbance	Never
Physical Weakness	Rarely	Tiredness	Sometimes
Joint Pain	Never	Difficulty Concentrating	Rarely
Poor Reaction Times	Never	Slow Reaction Times	Rarely

Multiple Kruskal-Wallis tests identified no significant differences between jockey codes for any of the physiological and psychological effects tested (see Tables 12 and 13) (see Appendices L and M).

Table 12 – The percentage of jockeys experiencing different perceived physiological effects associated with weight control

Physiological Effect	National Hunt *n=29*	Flat *n=12*	Dual Purpose *n=5*	P value
Muscle Cramps	70	55	67	0.083
Fever	19	18	0	0.059
Nausea	39	18	25	0.451
Dizziness	52	64	75	0.747
Fainting	11	18	25	0.650
Stomach Cramps	52	36	67	0.625
Poor Circulation	54	18	25	0.075
Fatigue	67	82	100	0.441
Visual Distortion	21	36	0	0.127
Joint Pain	48	36	25	0.276
Physical Weakness	74	82	100	0.603
Poor Reactions	58	27	50	0.403

Table 13 – The percentage of jockeys experiencing different perceived psychological effects associated with weight control

Method	National Hunt *n=29*	Flat *n=12*	Dual Purpose *n=5*	P value
Persistent Thirst	80	91	100	0.133
Persistent Hunger	80	91	100	0.427
Short term Memory Loss	42	18	0	0.149
Long term Memory Loss	20	9	0	0.242
Mood Swings	72	9	100	0.220
Anxiety	35	36	0	0.131
Depression	52	36	67	0.744
Anger	60	91	100	0.122
Sleep Disturbance	44	54	0	0.086
Tiredness	89	83	100	0.460
Difficulty Concentrating	54	54	67	0.859
Poor Reactions	52	54	67	0.810

Spearman's Rank correlation identified several of the weight control methods that the participants engaged in to be associated with a number of the negative physiological and psychological effects reported to be experienced by jockeys. The most notable weight control methods that elicited the strongest correlation with physiological or psychological symptoms were those inducing dehydration, namely fluid restriction, sauna use, exercise in a hot environment, exercise in a sweat suit and a hot, salt bath all of which were found to be moderately correlated with a number of negative effects (see Tables 14 and 15).

Table 14 - Spearman's Rank Correlation between the jockey's weight control methods and perceived physiological effects of weight control

Weight control method	Physiological effect	Correlation	P value
Food Restriction	Fatigue	$r_s = 0.341$	0.019*
	Physical Weakness	$r_s = 0.311$	0.033*
Fluid Restriction	Muscle Cramps	$r_s = 0.375$	0.009*
	Dizziness	$r_s = 0.342$	0.019*
	Fatigue	$r_s = 0.342$	0.018*
	Physical Weakness	$r_s = 0.359$	0.013*
Sauna	Muscle Cramps	$r_s = 0.382$	0.008*
	Dizziness	$r_s = 0.321$	0.028*
	Fatigue	$r_s = 0.293$	0.045*
	Visual Distortion	$r_s = 0.305$	0.037*
Appetite Suppressants	Stomach Cramps	$r_s = 0.308$	0.035*
Other Exercise	Fever	$r_s = 0.294$	0.045*
	Fainting	$r_s = 0.289$	0.049*
	Fatigue	$r_s =0.302$	0.039*
	Joint Pain	$r_s = 0.318$	0.030*
	Physical Weakness	$r_s = 0.315$	0.031*
Exercise in Hot Environment	Muscle Cramps	$r_s = 0.305$	0.037*
	Fever	$r_s = 0.298$	0.042*
	Nausea	$r_s = 0.458$	0.001**
	Dizziness	$r_s = 0.361$	0.013*
	Poor Circulation	$r_s = 0.372$	0.01*
	Visual Distortion	$r_s = 0.413$	0.004*
Exercise in a Sweat Suit	Muscle Cramps	$r_s = 0.418$	0.003*
	Nausea	$r_s = 0.437$	0.002*
	Dizziness	$r_s = 0.434$	0.002*
	Stomach Cramps	$r_s = 0.306$	0.37*
	Fatigue	$r_s = 0.307$	0.036*
	Visual Distortion	$r_s = 0.442$	0.002*
	Physical Weakness	$r_s = 0.350$	0.016*
Hot Salt Bath	Dizziness	$r_s = 0.554$	0.000**
	Fatigue	$r_s = 0.501$	0.001**
	Visual Distortion	$r_s = 0.343$	0.035*
	Physical Weakness	$r_s = 0.353$	0.030*
Cigarettes	Muscle Cramps	$r_s = 0.298$	0.042*

* denotes statistically significant $p<0.05$ ** denotes statistically significant $p<0.001$

Table 15 - Spearman's Rank Correlation between the jockey's weight control methods and perceived psychological effects of weight control

Weight control method	Physiological effect	Correlation	P value
Food Restriction	Persistent Thirst	$r_s = 0.315$	0.031*
	Persistent Hunger	$r_s = 0.029$	0.029*
	Mood Swings	$r_s = 0.025$	0.025*
	Anger	$r_s = 0.019$	0.019*
Fluid Restriction	Persistent Thirst	$r_s = 0.468$	0.006*
	Persistent Hunger	$r_s = 0.542$	0.008*
	Short term Memory Loss	$r_s = 0.372$	0.010*
	Long term Memory Loss	$r_s = 0.318$	0.029*
	Mood Swings	$r_s = 0.497$	0.000**
	Anxiety	$r_s = 0.290$	0.048*
	Anger	$r_s = 0.442$	0.002*
	Sleep Disturbance	$r_s = 0.299$	0.041*
	Difficulty Concentrating	$r_s = 0.413$	0.004*
Sauna	Persistent Thirst	$r_s = 0.468$	0.001**
	Persistent Hunger	$r_s = 0.542$	0.000**
	Short term Memory Loss	$r_s = 0.315$	0.031*
	Mood Swings	$r_s = 0.463$	0.001**
	Anxiety	$r_s = 0.307$	0.036*
	Depression	$r_s = 0.370$	0.010*
	Anger	$r_s = 0.462$	0.001**
	Sleep Disturbance	$r_s = 0.407$	0.004*
	Tiredness	$r_s = 0.328$	0.024*
	Difficulty Concentrating	$r_s = 0.354$	0.015*
	Poor Reactions	$r_s = 0.315$	0.031*
Laxatives	Persistent Hunger	$r_s = 0.296$	0.044*
	Mood Swings	$r_s = 0.308$	0.035*
Other Exercise	Short term Memory Loss	$r_s = 0.288$	0.05*
	Anxiety	$r_s = 0.288$	0.049*
	Sleep Disturbance	$r_s = 0.366$	0.011*
	Poor Reactions	$r_s = 0.288$	0.049*

Table 15 Continued.

Weight control method	Physiological effect	Correlation	P value
Exercise in Hot Environment	Persistent Thirst	$r_s = 0.302$	0.039*
	Short term Memory Loss	$r_s = 0.386$	0.007*
	Long term Memory Loss	$r_s = 0.421$	0.003*
	Anxiety	$r_s = 0.455$	0.001**
	Depression	$r_s = 0.602$	0.000**
	Sleep Disturbance	$r_s = 0.328$	0.024*
	Difficulty Concentrating	$r_s = 0.364$	0.012*
	Poor Reactions	$r_s = 0.439$	0.002*
Exercise in a Sweat Suit	Persistent Thirst	$r_s = 0.510$	0.000**
	Persistent Hunger	$r_s = 0.521$	0.000**
	Short term Memory Loss	$r_s = 0.412$	0.004*
	Long term Memory Loss	$r_s = 0.386$	0.007*
	Mood Swings	$r_s = 0.522$	0.000**
	Anxiety	$r_s = 0.499$	0.000**
	Depression	$r_s = 0.554$	0.000**
	Anger	$r_s = 0.550$	0.000**
	Sleep Disturbance	$r_s = 0.482$	0.001**
	Tiredness	$r_s = 0.292$	0.046*
	Difficulty Concentrating	$r_s = 0.433$	0.002*
	Poor Reactions	$r_s = 0.386$	0.007*
Hot Salt Bath	Persistent Thirst	$r_s = 0.459$	0.004*
	Persistent Hunger	$r_s = 0.581$	0.000**
	Short term Memory Loss	$r_s = 0.435$	0.006*
	Long term Memory Loss	$r_s = 0.366$	0.007*
	Mood Swings	$r_s = 0.593$	0.000**
	Anxiety	$r_s = 0.455$	0.004*
	Depression	$r_s = 0.517$	0.001**
	Anger	$r_s = 0.681$	0.000**
	Sleep Disturbance	$r_s = 0.470$	0.003*
	Difficulty Concentrating	$r_s = 0.588$	0.000**
	Poor Reactions	$r_s = 0.477$	0.002*
Cigarettes	Persistent Thirst	$r_s = 0.328$	0.025*
	Short term Memory Loss	$r_s = 0.407$	0.005*
	Mood Swings	$r_s = 0.418$	0.003*
	Anger	$r_s = 0.377$	0.009*
	Sleep Disturbance	$r_s = 0.299$	0.041*
	Difficulty Concentrating	$r_s = 0.375$	0.009*
	Poor Reactions	$r_s = 0.342$	0.019*

* denotes statistically significant p<0.05 ** denotes statistically significant p<0.001

CHAPTER 5

DISSCUSSION

5.0 Discussion

Participation in weight category sports poses a unique set of challenges to the athlete, the extent of which will be determined by the specific demands of the sport on the individual in question (Dolan, 2010). The aim of the study was to investigate the body mass control methods of UK flat and National Hunt jockeys.

5.1 'Making Weight' for racing

Jockeys are required to 'make weight' repeatedly and for prolonged periods as there is no discernible off-season (Burke, 2007). Jockeys are required to weigh-out 30 minutes prior to the race fully clothed and carrying their saddle (Dolan et al., 2011) and must then maintain their weight throughout the race and weigh-in again immediately after. This allows for limited opportunities to refuel or rehydrate particularly when they may have to weigh-out again for subsequent races shortly after (Warrington et al., 2008). It was hypothesised that all jockeys will employ short-term weight loss methods in order to 'make weight' for racing.

Although often, jockeys are naturally lean, many appear to follow a chronically energy restricted lifestyle and rely on the use of rapid weight loss strategies in the days leading up to a race (Dolan, 2010; Moore et al., 2002). Severe energy restriction has been shown to induce protein oxidation so reducing fat free mass and muscular strength (Dolan, 2010). A reduction in muscle mass is undesirable for all athletes but particularly for jockeys who not only require a great deal of strength to control a galloping horse but also because the associated reduction in RMR can make weight maintenance and further weight loss more challenging. Rapid weight loss via food and fluid restriction has been found to compromise hydration status, muscle and liver glycogen stores and potentially circulating blood glucose concentration, all of which are necessary for maintenance of usual physiological, cognitive, metabolic and osteogenic function (Dolan, 2010). Most jockeys report weight management to be difficult (Moore et al., 2002) with 52% reported to identify weight control as the most challenging aspect of life as a jockey (Dolan et al., 2011). In the current study 68 % of jockeys reported some degree of difficulty in managing their weight which is higher than previously reported percentages of 46% and 43% (Atkinson et al., 2001; Moore et al, 2002).

The study found 49% of jockeys indicated that they usually have to 'make weight' to reach their riding weight and this is lower than previously reported (Moore et al., 2002). As a population, jockeys are generally naturally lean with low body fat levels and increased muscle mass. Therefore in order to reach even lower racing weights 'wasting' behaviours are often necessary. The average BMI for the participants in the current study reflects this. A BMI of 19.8 kg/m^2 is considered to be at the lower end of a healthy weight for their height (McArdle et al., 2001).

Despite many finding weight control challenging, it appears that the need for strict management routines is generally accepted; 74% of the jockeys studied had not consulted a nutritionist in the past regarding managing their weight, in contrast to the jockeys studied by Atkinson et al. (2001) in which 73% of participants had consulted a dietician at some point. It can therefore be assumed that most of the knowledge and theory upon which jockeys base their methods of weight control is passed on by peers and not from consulting a qualified health professional.

Smoking is often used as a form or weight control due to its appetite suppressing qualities; 37% of jockeys smoked, a similar number to other studies by Dolan et al. (2011) (38%) and Atkinson et al. (2001) (41%). Smoking was found to be moderately correlated with a number of negative physiological and psychological symptoms. The strongest correlations were found between smoking and short term memory loss ($r_s = 0.407$; p=0.005), mood swings ($r_s = 0.418$; p=0.003), anger ($r_s = 0.377$; p=0.009), difficulty concentrating ($r_s = 0.375$; p=0.009) and poor reactions ($r_s = 0.342$; p=0.019).

Jockeys indicated that often their lifestyle results in them making poor food choices and that being too tired to cook and eating what is readily available affected what they ate most frequently. Racing takes place in the afternoons and also in the evenings in summer months. Jockeys are therefore likely to eat very little in the morning prior to racing and then choose the most convenient and quickest meal in the evenings following racing as they are likely to be very hungry having eaten very little during the day. Atkinson et al. (2001) found 92% of jockeys missed lunch on race days which is likely to be due to the timing of races and the need to maintain a low body weight to make their racing weight.

Athletes have a greater micronutrient requirement than the general population in order to cope with the increased energy flux and physiological stress. Previous studies have shown substantial portions of jockeys sampled failed to meet the recommended daily allowance for most nutrients (Dolan, 2010). Average daily diet data generally indicated a low daily intake of fruit and vegetables (18% and 30% respectively) with 48% regularly consuming chocolate, sweets or biscuits at least once per day. Previous studies have shown a strong reliance on convenience foods that tend to be energy dense, high in fat and low in fibre and micronutrients (Dolan, 2010).

Tea and coffee was consumed at least once a day by 50% of participants but compared to some studies jockeys consumed a relatively low amount of alcohol per week (5±8.28 units) below the current recommended maximum guidelines of 21-28 units per week for men (Drink Aware, 2012). Alcohol has little nutritional value and may impair rehydration and glycogen storage after exercise (Dolan, 2010). A previous study has found that National Hunt jockeys consumed caffeine and alcohol more frequently than their flat racing counterparts ($P<0.05$) (Atkinson et al., 2001). In the present study flat jockeys consumed more alcohol (5.3±3.67 units) than their National Hunt (2.5±3.25 units) or Dual Purpose (0.5±1 units) counterparts.

5.2 Dehydration and Weight Control

Dehydration occurs when there is inadequate water available to maintain the required water levels within body tissue and systems. Athletes regularly engaging in short-term weight management strategies such as saunas and sweat suit exercise are at a high risk of dehydration and the associated physical consequences, in the extreme heart failure and death (Sullivan, 2008). A number of studies have previously reported most jockeys to be habitually dehydrated on both non-race days and to a greater extent on race days (Dolan, 2010; Sullivan, 2008; Warrington et al., 2009). It was hypothesised that all jockeys actively or passively dehydrate in an effort to reach their racing weight.

In order to make their racing weight, 39% of jockeys indicated that they had had to lose an average of 3 to 4 lbs during the last seven days prior to participating in the study. Jockeys indicated that they lost approximately 1.9±2.9 lbs for their last race over a period of 1±1.5 days. Dolan et al. (2011) also found 86% of jockeys to start losing 2kg (4lbs 6.5 oz) 24-48 hours before a designated race day. Dolan (2010) found that no jockeys started losing weight for a race more than 3 days before, in the current study only three jockeys commenced their weight loss for their last race more than two days before with one losing 4 lbs in just two hours prior to the race. It can therefore be concluded that despite 77% of jockeys indicating that they try to maintain a low weight rather than relying on rapid weight loss, most will resort to the use of short term weight loss strategies in the days leading up to a race which will inevitably include methods to promote fluid loss. Filaire et al. (2001) reported an average weight loss in judoka players of 3.6 kg as a result of seven day dietary restriction to equate to only 1 kg of body mass loss and therefore it is assumed that dehydration also contributed to the weight loss even over a seven day period.

A number of the most common weight control methods used by jockeys either actively or passively aim to promote dehydration;

- Fluid restriction
- Food restriction
- Sauna
- Exercise in a sweat suit
- Exercise in a hot environment
- Hot, salt baths
- Laxative abuse

Fluid, electrolyte and pH homeostasis are all tightly regulated through the body's water medium. Imbalances in any of these systems have many detrimental consequences for usual metabolic, physiological and cognitive processes (Dolan, 2010). Performance decrements occur at a dehydration threshold of 2% body mass loss and are attributed mainly to a reduced plasma volume as a result of dehydration and reduced muscle glycogen. Strength and power appears to be affected to a lesser extent by the effects of dehydration but impaired mental attention and increased subjective feelings of fatigue may contribute to performance decrements as a result of dehydration (Dolan, 2010).

Despite this, even mild levels of dehydration of approximately 1.5% body mass, such as that induced through exercising in a sweat suit and restricted fluid intake is sufficient to cause a shift in the lactate threshold to a lower percentage of VO_2 max reducing the time to fatigue (Dolan, 2010). Excessive dehydration has been linked to the deaths of three American collegiate wrestlers and excessive weight control and dehydration was cited as the possible reason for the deaths of two young American jockeys (Dolan, 2010).

Studies on athletes in other sports have shown that those able to eat or drink following weighing out and prior to competition were not able to fully restore their plasma volume and glycogen stores in the available time period (Sullivan, 2008), however even partial refuelling and rehydration is preferable to the situation afforded to jockeys who are unable to eat or drink as they must maintain their weight throughout the race and be weighed in again at the same weight immediately afterwards.

Additional exercise (98%), riding exercise (96%), sauna use (78%), food restriction (74%) and fluid restriction (64%) were the most common weight control methods used by jockeys with many jockeys also using exercise induced sweating in induce fluid loss; 59% exercise in a sweat suit and 41% exercising in a hot environment. Atkinson et al. (2001) also found saunas, exercise and fasting to be the most popular body mass control methods with 2% using laxatives or diuretics as opposed to the 6% using laxatives in the current study. Regular use of laxatives will lead to dehydration and could cause electrolyte and mineral imbalances (Dolan, 2010). Diuretics are currently banned under the rules of racing in the UK and so were not tested for (The British Horseracing Board and The Horseracing Regulatory Authority, 2007).

A well-trained athlete will have a twenty fold increase in heat metabolism during exercise. Regularly experiencing heat stress enables athletes to develop a higher heat tolerance than people who exercise little. Nevertheless, a drop in hydration of more than three percent of body weight is a significant risk factor for heat illness including heat oedema, heat syncope, heat cramps, heat exhaustion and heat stroke (Sullivan, 2008). However a major limit of dehydration studies is in the methods used to induce dehydration as exercise and heat represent individual physiological stressors making it hard to isolate the effects of dehydration (Dolan, 2010).

The percentages of jockeys engaging in these weight control methods were similar to those previously reported by Dolan et al. (2011) further indicating that jockeys rely on weight control methods that promote fluid loss. This may be due in part to the fact that generally jockeys are naturally lean and have very low body fat levels with levels of 9.5±3.1% body fat reported previously (Dolan et al., 2011). Wasting behaviours are therefore often deemed necessary to reach the required weight which inevitably leads to a loss of body fluid and lean tissue (Sullivan, 2008; Warrington et al., 2009). In addition, due to the financial uncertainty of horseracing, a jockey's career often depends on their ability to take 'light rides at minimum notice (Dolan et al., 2011).

Of the weight control methods found to be correlated with negative physiological and psychological symptoms, those most strongly associated were the weight control methods that induced fluid loss. Previous evidence in jockeys suggests that dehydration is the primary method or weight control along with severely restricted food and fluid intake and this has been shown to negatively impact on performance in many sports including judo, boxing and wrestling. Certain amounts of dehydration are tolerable to the human body but it is unlikely that jockeys can become habituated to high levels of dehydration (Dolan, 2010), it is more likely that they just become accustomed to living with the negative symptoms such as tiredness and persistent thirst

Hypernatremia has been previously reported in a groups of jockeys on race days (Warrington et al., 2009) despite the development of voluntary hypernatremia being rare due to the body's strong thirst response (Dolan, 2010) . Fluid restriction was most strongly associated with persistent thirst (r_s = 0.468; p=0.006), persistent hunger (r_s = 0.542; p=0.008), mood swings (r_s = 0.497; p=0.000), Anger (r_s = 0.442; p=0.002), difficulty concentrating (r_s = 0.413; p=0.004) muscle cramps (r_s = 0.375; p=0.009), dizziness (r_s = 0.342; p=0.019), fatigue (r_s = 0.342; p=0.018) and physical weakness (r_s = 0.359; p=0.013).

Sauna use was most strongly associated with persistent hunger (r_s = 0.542; p=0.000), persistent thirst (r_s = 0.468; p=0.001), mood swings (r_s = 0.0463; p=0.001), Anger (r_s =0.462; p=0.001), sleep disturbance (r_s = 0.407; p=0.004) and muscle cramps (r_s = 0.382; p=0.008). The installation of saunas at every racecourse will only encourage the reliance on their use for rapid weight loss prior to racing. For many the sauna has become a home away from home (Baum, 2006). Sauna abuse has been associated with a range of negative health outcomes in eating disorder patients including fluid, electrolyte and acid-base imbalance, abnormally low lood pressure, hyperventilation, increased blood alkalinity and hypertension (Caulfield & Karageorghis, 2008).

Exercise in a hot environment was most strongly associated with nausea (r_s = 0.458; p=0.001), visual distortion (r_s = 0.413; p=0.004), short and long term memory loss (r_s = 0.386; p=0.0.007 and r_s = 0.421; p=0.003 respectively), Anxiety (r_s = 0.455; p=0.001), depression (r_s = 0.602; p=0.000) and poor reactions (r_s = 0.439; p=0.002).

Exercise in a sweat suit was most strongly associated with muscle cramps (r_s = 0.418; p=0.003), nausea (r_s = 0.437; p=0.002), dizziness (r_s = 0.434; p=0.002), visual distortion (r_s = 0.442; p=0.002), persistent thirst (r_s = 0.510; p=0.000), persistent hunger (r_s = 0.521; p=0.000), short and long term memory loss (r_s = 0.412; p=0.004 and r_s = 0.386; p=0.007 respectively), mood swings (r_s = 0.522; p=0.000), anxiety (r_s = 0.499; p=0.000), depression (r_s = 0.554; p=0.000), anger (r_s = 0.550; p=0.000), sleep disturbance (r_s = 0.482; p=0.001), difficulty concentrating (r_s = 0.433; p=0.002) and poor reactions (r_s = 0.386; p=0.007). Hyperosmotic hypervolemia is the most common form of dehydration caused by exercise as the composition of sweat is hypertonic to that of plasma (Dolan, 2010). Exercise induced sweating enhanced through exercising in a hot environment or sweat suit will exacerbate this.

Hot salt bath was most strongly correlated with dizziness (r_s = 0.554; p=0.000), fatigue (r_s = 0.501; p=0.001), persistent thirst (r_s = 0.459; p=0.004), persistent hunger (r_s = 0.581; p=0.000), short and long term memory loss (r_s = 0.435; p=0.006 and r_s = 0.366; p=0.007 respectively), mood swings (r_s = 0.593; p=0.000), anxiety (r_s = 0.455; p=0.004), depression (r_s = 0.517; p=0.001), anger (r_s = 0.681; p=0.000), sleep disturbance (r_s = 0.470; p=0.003), difficulty concentrating (r_s = 0.588; p=0.000) and poor reactions (r_s = 0.477; p=0.002).

Jockey's require strength, balance, cardiovascular fitness, specific handling skills and the ability to maintain high levels of concentration. Dizziness, physical weakness, tiredness, difficulty concentrating, poor reactions, fatigue and visual distortion are all not only harmful to performance but potentially dangerous when controlling a 500 kg horse at speeds in excess of $60km.h^{-1}$.

5.3 Differences in weight control methods between Flat, National Hunt and Dual Purpose jockeys

Due to the lower weights required in flat racing, it was hypothesised that flat race jockeys are more dependent on short-term weight loss methods due to the lower racing weights required. However no significant differences were found between jockey codes for any of the weight control methods tested.

When compared to the general UK population mean height of 1.75±0.11m (The NHS, 2009), the height of National Hunt jockeys was approximately average (1.76±0.05m) but the flat and dual purpose jockeys were shorter than average (1.64±0.05m and 1.70±0.06m respectively). All codes of jockey were lighter at their non-racing weight than the general UK population mean weight of 83.6±0.23 kg (The NHS, 2009) indicating that jockeys do indeed tend to be naturally shorter, leaner and lighter than the general population as suggested by Leydon and Wall (2002).

National Hunt jockeys were found to be significantly taller than flat jockeys and significantly heavier at their non-racing weight than flat jockeys which is in agreement with several other studies (Atkinson et al, 2001; Dolan et al., 2011; Warrington et al., 2009). However National Hunt jockeys were also significantly heavier at their non-racing weight than dual purpose jockeys despite not being significantly different in height. Only National Hunt jockeys were found to have a significant difference between their non-racing weight and lowest racing weight. This may be due to National Hunt jockeys being taller in height than the flat jockeys, as flat jockeys have a lower minimum weight of 7 stone 12 lbs as opposed to 10 stone in National Hunt.

Often young flat jockeys will become National Hunt jockeys if they have grown too tall to make the weight on the flat. The dual purpose jockeys were not significantly different in height to the

National Hunt jockeys but they were younger (median age 19.5 years as opposed to 23.5 years) and therefore possibly less physically mature. Flat jockeys had been race riding longer and had more rides per week than National Hunt and Dual Purpose jockeys, although not significant.

It is likely that the lack of difference in weight control methods between codes is explained by the flat jockeys being shorter and lighter than their National Hunt and dual purpose counterparts. This is reflected in the fact that all groups of jockeys had very similar BMI values at their lowest racing weight, a measurement that takes height into account (National Hunt 19.8 kg/m^2, flat 19.1 kg/m^2 and dual purpose 19.8 kg/m^2). This finding was also seen in other studies in which weight loss strategies and dietary intakes were found to be common between the groups indicating that weight management poses similar challenges for both groups (Atkinson et al., 2011; Dolan et al., 2011).

5.4 The negative Physiological and Psychological effects of weight control

It was hypothesised that Flat race jockeys experience more negative physical and psychological effects as a result of their weight control methods due to being more dependent on short-term weight loss methods. However as previously discussed, there were no significant differences found between jockey codes for any of the weight control methods and neither was there any significant differences in negative physical or psychological effects tested, disproving the hypotheses.

However rapid weight loss strategies such as those used by jockeys are associated with a number of negative physiological and psychological effects (Caulfield & Karageorghis, 2008; Dolan, 2010; Sullivan, 2008). Acute, short-term energy restriction impacts negatively on exercise performance in addition to promoting loss of muscle mass and bone mineral density and increasing the jockeys' susceptibility to injury, fatigue and infection (Dolan et al., 2011).

In jockeys, the cognitive effects of rapid weight loss strategies are of particular concern. Anger, fatigue, confusion, tension, short term memory impairment and mood swings have all been shown to be affected by rapid weight loss and it is thought that changes in exercise behaviours, reduced blood volume, sleep disturbances or hypoglycaemia may all play a part in this (Dolan, 2010). High levels of fatigue are dangerous for those jockeys driving hundreds of miles across the country to and from race meetings and anger can lead to strain on relationships with significant others, therefore reducing their network of support in times of stress (Caulfield & Karageorghis, 2008). Fatigue and a lack of energy, irritability and difficulty sleeping are all identified as symptoms of General Anxiety Disorder (Sullivan, 2008).

In this study 90% of all jockeys reported symptoms of persistent thirst and hunger, these levels are much greater than those previously reported by Dolan et al. (2011) (52% and 38% respectively). However when rated on a likert scale (1-10) median scores for thirst and hunger equalled 6 indicating a notable level of discomfort (Dolan et al., 2011).

The weight loss methods frequently engaged in by jockeys are often extreme and pervasive in the progression and require jockeys to sacrifice their health long term (Sullivan, 2008). In retired South African jockeys 25% suffered from musculoskeletal problems, 13% gastrointestinal problems and 5% from renal problems. Whilst these cannot be attributed entirely to weight control behaviours it can be concluded that they contributed to harming the long term health of jockeys (Labadarios et al., 1993).

Atkinson et al. (2001) identified one flat jockey to be clinically diagnosed as suffering from *Bulimia Nervosa.* Although eating disorders were not clinically tested for in the current study a number of jockeys displayed disturbed eating behaviours and a reliance on weight control methods such as food avoidance and sauna use, behaviours which could be identified as symptoms of *anorexia athletica*. One flat jockey consumed a daily diet that consisted of tea and coffee, one or two biscuits and a bowl of Alpen with a small portion of fish or pasta once a week. Another appeared to exist on fruit, yoghurt, water and tea (See Appedix D). These eating behaviours cannot be considered normal and while the participants may not display any or all of the psychological symptoms associated with eating disorders the use of extreme weight control behaviours is based upon performance (Sudi et al., 2004; Sundgot-Borgen & Torstveit, 2004).

5.5 Limitations and recommendations for future research

The timing of the data collection may have impacted on the results, particularly for the National Hunt jockeys as the summer is a quieter time of year and the races attract a poorer calibre of horse with more novice and lower value races. Therefore it is possible that trainers will give rides to younger, amateur or conditional jockeys to further their experience but this will have reduced the median age of the sample and consequently may not be representative of the professional population. This may have affected results in two ways; Younger jockeys may be less physically mature and therefore not experience as much difficulty maintaining their weight or they may face additional struggles with their weight due to claiming a weight allowance.

Due to logistical and methodological issues, the sample size remained quite small, although larger than some studies on this population (Caulfield & Karageorghis, 2003; Dolan et al., 2001;

Warrington et al., 2009) this could have affected the identification and interpretation of the results particularly when making comparisons between jockey codes particularly as there were few Dual Purpose jockeys (n=6). Gaining a bigger sample size from racecourses throughout the UK or preferably via email would give a more accurate view of the population and enable clearer comparisons to be made.

Despite performing a pilot study, the questionnaire was judged to be slightly too long to complete on a race day between races, particularly for flat jockeys as flat races are shorter in duration and between races the jockeys were either riding or sweating in the sauna. A smaller number of flat jockeys were therefore able to participate in the study. Contacting jockeys via email to enable jockeys to complete the questionnaire in their own time and not when under the pressure of the race environment would be a preferred method of data collection. The data collected for physical and psychological effects of the jockey's weight control is subjective and may have been influenced by their previous rides that day or by their prospective chances in upcoming races. The possibility of this affecting the results would be minimised if data was collected via email.

Analysis of a seven-day food and physical exercise diary would provide information on energy intake and expenditure. The energy expenditure of jockeys during a race still remains unclear. Although the energy expenditure of each jockey will vary according to the type of race, race conditions and horse they are riding, obtaining heart rate data during a variety of races or indirect calorimetry during a simulated race on an equicizer mechanical horse in a laboratory setting would provide a more accurate estimation of the daily demands of horse racing (McArdle et al., 2001).

As this study has identified key weight control methods used and their association with a variety of physiological and psychological effects it would be possible to isolate these weight control methods and investigate how and why they impact upon the jockeys and more specifically would enable recommendations to be given on how to minimise these effects. In particular the impact of dehydration on jockeys and how it affects performance is an important area to highlight as it appears that many jockeys actively or passively dehydrate in an effort to reduce their body weight and have learnt to live with many of the uncomfortable side effects.

As the challenges of making weight have become so entrenched and accepted within the sport, in order to convince jockeys to alter their lifestyle and weight control strategies it may be necessary to investigate how the weight control strategies currently relied upon impact negatively on performance as like many athletes, they may be more open to change if they can see how it will benefit their performance and hence riding career and livelihood. It may be difficult to persuade older, already successful jockeys to change their weight control behaviour but it is important to educate young jockeys at the start of their career to prevent them relying on the knowledge of their peers and their often unhealthy weight control methods.

CHAPTER 6

CONCLUSION

6.0 Conclusion

Horseracing poses a challenge to a jockey that is unlike in any other weight category sport. Despite often being smaller, lighter and leaner than the general population, the nature of the handicapping system integral to racing means that jockeys are required to sustain body weights often well below that which their physique would naturally dictate. While it remains unlikely that the minimum weight limits in flat and National Hunt racing are likely to be increased in the near future, rapid weight loss methods are used 1±1.5 days prior to a race, commonly those that promote fluid loss and induce dehydration are often deemed necessary to reach the required weight due to jockeys already having low levels of body fat and increased muscle mass.

All jockeys face the same weight control demands irrespective of jockey code as due to the lower minimum weights in flat racing these jockeys tend to be naturally shorter and lighter than their National Hunt counterparts.

The weight control methods commonly used by jockeys such as food and fluid restriction, sauna use and exercise in sweat suits or a hot environment are associated with a number of negative physiological and psychological effects. Physiological effects such as fatigue, physical weakness and poor reactions are both detrimental to a jockey's performance and dangerous to those jockeys who frequently drive up to hundreds of miles all over the country to race meetings and are controlling a horse weighing 500 kg at speeds in excess of 60km.h^{-1}. Psychological symptoms of anger and irritability, depression, mood swings and difficulty concentrating are all both detrimental to performance and can lead to problems with significant others, reducing the avenues of psychological support available to them during times of stress. Greater negative mood states and disordered eating attitudes of jockeys are seen when jockeys are riding at their minimum weight and this suggests that in addition to the major risk to a jockey's physiological health, their psychological well being may also be at risk.

While in recent years research has enabled a greater understanding of the pressures and demands placed upon jockeys, it appears that this knowledge has not fully filtered down to the jockeys themselves particularly young jockeys at the start of their career. Jockeys tend to rely on the knowledge of their peers and less so on the knowledge of qualified health professionals. Jockeys have learnt to tolerate many of the negative physiological and psychological symptoms such as persistent thirst and hunger and have begun to accept them as a part of their lifestyle. More support and information should be provided to young jockeys at the start of their career to prevent them damaging their health while still physically immature and to help them prolong their career.

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Glossary

Apprentice	Flat jockey at the start of their career attached to a trainers yard and entitled to claim a weight allowance according to the number of winners they have ridden
Blinkers	Headwear worn on the horse to limit peripheral vision and minimise distraction
Bumper	National Hunt flat race run over distances of approximately 2 miles
Conditional	A professional National Hunt jockey at the start of their career attached to a trainers yard and entitled to claim a weight allowance according to the number of winners they have ridden
Eyeshield or Eyecover	A transparent eyeshield worn on the horses head to protect the eyes from dirt or mud thrown into the horses eyes by other horses hooves
Flat race	Race over 5 to 20 furlongs with no fences or obstacles
Hood	Headwear worn on the horse also see Blinkers
Hurdle	National Hunt races run over distances of 2 to 3 miles including a number of fences of 3 feet 6 inches
Making Weight	The practice of reducing body mass prior to competition

Plates	Lightweight aluminium horse shoes
Runners	Horses in the race
Skull cap	Jockeys protective headwear
Steeplechase	National Hunt races run over distances of 2 to 4 and a half miles including a number of fences of 4 feet 6 inches minimum
Trainer	The person issued a license responsible for the care and fitness of the horse
Visor	Headwear worn on the horse to limit peripheral vision and minimise distractions
Wasting	Rigorous regime to reduce body weight to absolute minimum.
Weigh-in	The process of re-weighing the jockey immediately following the race
Weigh-out	The process of weighing the jockey prior to the race to ensure they make the required weight
Weight cloth	A pad placed under the saddle designed to carry any additional weight in lead required by the jockey to make the necessary weight

Appendices

Appendix A – Racecourse letters of permission

CHESTER
RACECOURSE

www.chester-races.com

4th May 2010.

To Whom It May Concern.

I Jeannie Chantler do give permission to Arabella Higham to ask if jockeys at Chester Racecourse are happy to give information on their diet for research purposes.

Jeannie Chantler

General Manager

For Chester Races

DDI 01978 782081

BANGOR-ON-DEE

RACECOURSE

The Racecourse, Bangor On Dee, Wrexham, LL13 0DA.
Tel: 01978 780 323 Fax: 01978 780 985

To Whom It May Concern.

I Jeannie Chantler do give permission to Arabella Higham to ask if jockeys at Bangor on Dee Racecourse are happy to give information on their diet for research purposes.

Jeannie Chantler

General Manager

Bangor on Dee Races

DDI 01978 782081

Appendix B – Eating habits and body mass control questionnaire

University of Chester

An Invitation to participate in a research study on the eating habits and body weight control methods of National Hunt and Flat race Jockeys in the UK as part of a Masters degree in Exercise and Nutrition science at the University of Chester.

The key focus of this study is to investigate the current weight loss practices of jockeys and to gather information on the perceived impact of these practices on physical and psychological wellbeing.

Participation is entirely voluntary, anonymity is ensured and all information given will be kept confidential.

The attached questionnaire should take no longer than 10 minutes to complete.

Thank you for assisting in this research.

Eating Habits and Body Mass Control Questionnaire

Section 1 Personal and career information (please tick one box per question or specify where appropriate)

1. Gender

Male ☐ Female ☐

2. Age (years)

16-20 ☐ 21-26 ☐ 27-31 ☐ 32-40 ☐ 40+ ☐

3. Height ________ m/cm or feet/inches

4. Approximate weight when not racing________ kg or Stones/lbs

5. Flat ☐ National Hunt ☐ Dual Purpose ☐

6. Riding status

Professional ☐ Conditional/Apprentice ☐ Amateur ☐

If applicable state weight claimed ______ lbs

7. Duration of race riding career ________ yrs

8. Average number of race rides per week (during last full season)______ rides

9. Are you currently not riding for any reason?

No ☐ Yes ☐ If yes please specify why________________________________

Section 2 Weight Management and Lifestyle (please tick one box per question and specify where appropriate)

1. Do you have difficulty managing your weight?

Never ☐ Sometimes ☐ Usually ☐ Always ☐

2. Do you usually have to lose weight to make your riding weight?

No ☐ Yes ☐

If yes, how much on average (lbs)?

1-2 ☐ 3-4 ☐ 5-6 ☐ 7-8 ☐ 9-10 ☐ 11-12 ☐ 13-14 ☐

14+ ☐

3. During the last 7 days, have you had to lose weight to make a riding weight?

No ☐ Yes ☐

If yes, how much on average (lbs)?

1-2 ☐ 3-4 ☐ 5-6 ☐ 7-8 ☐ 9-10 ☐ 11-12 ☐ 13-14 ☐

14+ ☐

4. At any time during your career have you ridden overweight?

Never ☐ Sometimes ☐ Often ☐

By how much ______ lbs

5. What is your lowest achievable riding weight? ________ Kg or Stones/lbs

6. Do you try to maintain your weight or rely on rapid weight loss?

Maintain ☐ Rapid weight loss ☐

7. How much weight did you lose for your last race (not including today's races)? ______ lbs

8. Over what period of time? ______ Days

9. Generally, would you eat or drink before a race?

Never ☐ Sometimes ☐ Often ☐ Always ☐

If yes, roughly how long before __________ hrs

10. Please consider the following weight management methods. Indicate with a ✗ the most appropriate response(s) for how often you use each weight-loss method (you may ✗ <u>one or more</u> responses). Also, in the last columns please indicate with a ✓ the reason for using each method <u>unless</u> you answered *never* for the frequency.

	Frequency of use ✗					**Reason for use ✓**	
Methods	**Never**	**Between race days**	**Day before race days**	**On race day**	**Daily**	**Maintain constant weight**	**Lose weight rapidly**
Food restriction	1	2	3	4	5	☐	☐
Fluid restriction	1	2	3	4	5	☐	☐
Sauna	1	2	3	4	5	☐	☐
Laxatives	1	2	3	4	5	☐	☐
Appetite suppressants	1	2	3	4	5	☐	☐
Riding exercise	1	2	3	4	5	☐	☐
Other exercise (eg. Running/swimming etc)	1	2	3	4	5	☐	☐
Exercising in hot environment	1	2	3	4	5	☐	☐
Exercising in sweat suit	1	2	3	4	5	☐	☐
Hot salt bath	1	2	3	4	5	☐	☐
Smoking cigarettes	1	2	3	4	5	☐	☐
Other (please specify)	1	2	3	4	5	☐	☐

11. Average time spent doing additional exercise per week (for example running/swimming/gym) ________ hrs

12. Average number of weekly sweating sessions _______hrs

Please circle type and indicate duration

Sauna _____ hrs Bath ______ hrs Exercise in sweat suit ____ hrs

Other _____ hrs

13. Please consider the following physical effects experienced whilst wasting. Indicate with a ✗ the most appropriate response for how often you experience the effects (please only ✗ <u>one</u> response per statement). Also, in the last columns indicate with a ✓ the severity of the experience unless you answered *never* for the frequency.

	Frequency ✗					**Severity** ✓	
Physical effect	**Never**	**Rarely**	**Sometimes**	**Often**	**Always**	**Minor**	**Severe**
Muscle cramps	1	2	3	4	5	☐	☐
Fever	1	2	3	4	5	☐	☐
Nausea	1	2	3	4	5	☐	☐
Dizziness	1	2	3	4	5	☐	☐
Fainting	1	2	3	4	5	☐	☐
Stomach cramps	1	2	3	4	5	☐	☐
Poor circulation	1	2	3	4	5	☐	☐
Fatigue	1	2	3	4	5	☐	☐
Visual distortion/impairment	1	2	3	4	5	☐	☐
Joint pain	1	2	3	4	5	☐	☐
Physical weakness	1	2	3	4	5	☐	☐
Delayed/poor reaction times	1	2	3	4	5	☐	☐
Other (please specify)	1	2	3	4	5	☐	☐

14. Please consider the following psychological effects experienced whilst wasting. Indicate with a ✗ the most appropriate response for how often you experience the effects (please only ✗ one response per statement). Also, in the last columns indicate with a ✓ the severity of the experience unless you answered *never* for the frequency.

	Frequency ✗					**Severity** ✓	
Psychological effect	**Never**	**Rarely**	**Sometimes**	**Often**	**Always**	**Minor**	**Severe**
Persistent thirst	1	2	3	4	5	☐	☐
Persistent hunger	1	2	3	4	5	☐	☐
Short term memory loss	1	2	3	4	5	☐	☐
Long term memory loss	1	2	3	4	5	☐	☐
Mood swings	1	2	3	4	5	☐	☐
Anxiety	1	2	3	4	5	☐	☐
Depression	1	2	3	4	5	☐	☐
Irritability/anger	1	2	3	4	5	☐	☐
Sleep disturbance	1	2	3	4	5	☐	☐
Tiredness	1	2	3	4	5	☐	☐
Difficulty concentrating	1	2	3	4	5	☐	☐
Slow/poor reactions/response times	1	2	3	4	5	☐	☐

15. Briefly describe your average daily diet giving an estimation of number and size of portions ie. Small, medium or large.

Breakfast ____

Lunch ____

Supper ____

____

Snacks/Drinks ____

16. Average number of units of alcohol per week________units

17. Please consider the following statements that influence your food choices. Indicate with a ✗ the most appropriate response for when they apply (you may ✗ <u>one</u> response per statement).

	Frequency ✗				
Factors influencing food choice	**Never**	**Rarely**	**Sometimes**	**Often**	**Always**
Due to working hours I eat at irregular times	1	2	3	4	5
I am often too tired to prepare food	1	2	3	4	5
I do not have good cooking skills	1	2	3	4	5
I eat what is readily available	1	2	3	4	5
I am not often in a position to be able to prepare my own food	1	2	3	4	5
I do not have time to buy and prepare food	1	2	3	4	5

18. Have you consulted a nutritionist in the past regarding managing your weight?

No ☐ Yes ☐

Thank you for taking the time to complete this questionnaire.

Appendix C – Raw height and weight data

Participant	Gender	Height (m)	Non-racing weight (kg)	BMI (kg/m^2)	Lowest racing weight (kg)	Lowest BMI (kg/m^2)
1	M	1.83	68.00	20.31	66.7	19.92
2	M	1.78	67.10	21.18	58.1	18.34
3	M	1.65	57.3	21.05	57.2	21.01
4	M	1.75	61.70	20.15	60.8	19.85
5	M	1.80	57.8	17.84	60.3	18.61
6	M	1.68	57.3	20.30	57.2	20.27
7	M	1.68	57.6	20.41	56.2	19.91
8	M	1.80	61.20	18.89	59	18.21
9	M	1.70	57.20	19.79	57.2	19.79
10	M	1.75	61.70	20.15	61.7	20.15
11	M	1.80	62.10	19.16	60.3	18.61
12	M	1.75	64.40	21.03	60.3	19.69
13	M	1.83	65.80	19.65	61.7	18.42
14	M	1.83	59.40	17.74	59.4	17.74
15	M	1.63	52.20	19.65	47.6	17.92
16	F	1.68	64.90	22.99	61.7	21.86
17	M	1.78	63.50	20.04	60.3	19.03
18	F	1.78	59.00	18.62	59.0	18.62
19	F	1.72	63.50	21.46	63.5	21.46
20	M	1.78	63.50	20.04	61.2	19.32
21	M	1.78	62.10	19.60	61.7	19.47
22	M	1.80	66.70	20.58	61.2	18.89
23	M	1.68	57.5	20.37	53.5	18.96
24	M	1.72	76.20	25.76	64.4	21.77
25	M	1.68	62.60	22.18	62.6	22.18
26	M	1.80	66.70	20.59	63.5	19.60
27	M	1.72	66.70	22.55	61.7	20.86
28	M	1.72	63.50	21.46	61.7	20.86
29	M	1.72	/	/	61.2	20.69
30	M	1.72	67.10	22.68	64.4	21.77
31	M	1.80	59.00	18.21	58.1	17.93
32	M	1.72	66.20	22.37	61.7	20.86
33	M	1.75	62.10	20.28	62.1	20.28
34	M	1.78	63.50	20.04	60.3	19.03
35	M	1.68	51.50	18.25	53.1	18.81
36	M	1.65	51.60	18.95	54	19.83
37	M	1.68	67.90	24.06	52.2	18.49
38	M	1.60	45.02	17.59	47.6	18.59
39	M	1.55	51.50	21.44	52.2	21.72
40	M	1.68	50.80	18.00	49	17.36
41	M	1.55	55.88	23.26	51.7	21.52
42	M	1.68	57.15	20.25	51.7	18.32
43	M	1.65	51.50	18.92	53.1	19.50
44	M	1.60	51.25	20.02	50.8	19.84
45	M	1.65	51.18	18.80	47.6	17.48
46	M	1.70	51.37	17.78	52.2	18.06

Appendix D- Raw meal data

Participant	Breakfast	Lunch	Supper	Drinks/Snacks
1	2 Slices Toast	Small Sandwich	Medium cooked meal meat potatoes and vegetables	small chocolate can of coke ribeana
2	1 Lemon	Steak or Fish and Pasta	2 hard boiled eggs and green salad	Beer and water
3	Medium porridge or cereal	Scrambled egg/beans on toast yoghurt	Pasta, Ready meal and Peas, Chicken Chips and Peas Yoghurt	1 Cup Hot Chocolate, Squash, slice of cake, apple, flapjack
4	Coffee Chocolate	Toast	Main Meal	Coffee Chocolate Lucozade
5	Toast	Sandwich and Chocolate bar	Small meal	Crisps
6	Small	Small	Medium	Small
7	Tea	Medium bowl of pasta or cereal	Cereal or toast	Lemonade or milk
8	Sausage and bacon roll	Nothing	Nice sized meal	Sweets/crisps Red Bull
9	Bacon Sandwich	Nothing or sweets sometimes	McDonalds take away	Sweets/Chocolate Lucozade
10	Coffee	Coffee and Toast	Light Meal	Chocolate, Crisps and Coke
11	Juice	2 Slices of toast	Small meal	7-8 Cups of Tea and Biscuits, bottle of Juice
12	Cereal or Medium Sandwich	Medium Sandwich or Soup, Chocolate	Chicken/Meat and Vegetables	Chocolate, Sweet Tea
13	Fried Breakfast	Cup of Tea	Takeaway	Fizzy Drinks
14	Porridge or Cereal/Fried Breakfast	Sausages or Sandwich	Large Roast Dinner or Pasta	Lots
15	Medium Cereal 4 slices Brown Toast and Butter	Chicken/egg Sandwich, Crisps, Yoghurt, Orange, Chocolate	Medium Mashed potato and beans or meat and vegetables	Water, Iced Lollies and Squash
16	Crunchy Nut Cornflakes	Vegetable Soup	2 Slices Brown Toast	Water
17	Coffee and Sweets	Coffee, Biscuits and Sandwich	Chicken and Vegetables/ Spagetti Bolognaise/ Lamb Stew	Lucozade Sport, Sweets, Chocolate
18	Bananna or yoghurt	Ham salad or tuna wrap	Chicken	Tea water fruit and biscuits
19	Fruit	Chicken wrap	Meat/Fish eat out once a week	water/squash no alcohol
20	Small	Medium	Medium	Medium
21	2 Slices Toast	Chicken salad sandwich	Meat vegetables roast potatoes or chicken stir fry	3-4 Hob Nob biscuits/ beer, squash, tea, coffee
22	Medium Porridge	Large Soup	Large bowl of vegetables	Water, Cranberry juice no sugar, diet coke
23	Medium	Large	Large	Lots

Raw Meal data contined.

24	Bananna 1 coffee	Fruit	Healthy tea, chicken wholewheat rice or pasta	Lucozade sport
25	Toast and Tea small	Sandwich and canned drink Medium	Some sort of medium meal	/
26	Cereal/toast/ poached egg and toast medium	sandwich/poached egg on toast medium	meat/pasta/rice/potatoes/sal ad large	tea, soft drink, squash
27	Tea fruit	Sandwich	None	Fruit/sweets
28	Small breakfast	None	Good dinner	Light snacks and drinks
29	None	Sandwich chocolate bar red bull	pasta/pizza/salad	Sweets, chocolate, crisps
30	tea and toast small	small sandwich	Normal medium	/
31	Drink, cereal, toast	Sandwich, chocolate, fruit	Pasta meat anything	Biscuits, squash
32	/	/	/	/
33	Cup of tea	Sandwich	Steak Medium	Sports drink, lots of tea, chocolate
34	2 bowls cereal orange juice large	2 bread rolls, 2 slices soreen loaf cup of tea large	Pizza chicken curry rice omlette glass of juice, 2-3 chocolate biscuits medium	Milk, tea and chocolate biscuits
35	Fruit	Yoghurt	None	Water and tea
36	Coffee and toast	Soup/Sandwich	Salad/ Salmon with veg/ Stir fry	Juice red bull tea or coffee
37	/	/	/	/
38	None	Sandwich small	Hot chocolate	None
39	Coffee 1 toast	tea ham and cheese sandwich	light meal chicken and boiled vegetables	wine
40	Piece of fruit or toast		Brown rice vegetables and steak	Energy bar/Red Bull
41	Cereal	Sandwich	Pizza	Chocolate/Coke
42	Cup of Coffee and chocolate bar	Cup of Tea	Bowl of Alpen once a wk sml portion fish or pasta	one or two biscuits
43	Milkshake	Milkshake	Fish	Fizzy Drinks
44	/	/	/	/
45	Coffee/slice of toast	/	Decent sized meal	Energy bars
46	/	Small meal	Small meal	/

Appendix E – Outputs for tests of difference in height between jockey codes

Test of Normality for Jockeys height (metres)

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Flat Jockey Heights	.225	5	.200*	.881	5	.315
NH jockey Heights	.164	5	.200*	.981	5	.942
Dual Purpose Jockey Heights	.421	5	.004	.727	5	.018

a. Lilliefors Significance Correction

*. This is a lower bound of the true significance.

Flat and National Hunt jockeys

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
jockey Heights	Equal variances assumed	1.010	.321	2.890	39	.006	.06566	.02272	.01971	.11161
	Equal variances not assumed			3.288	27.999	.003	.06566	.01997	.02476	.10656

National Hunt and Dual Purpose Jockeys

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of jockey Heights is the same across categories of VAR00002.	Independent-Samples Mann-Whitney U Test	.373	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Flat Jockeys and Dual Purpose Jockeys

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Height Metres is the same across categories of Type of Jockey.	Independent-Samples Mann-Whitney U Test	.110	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Appendix F – Outputs for tests of difference in non-racing weight between jockey codes

Test of Normality for jockeys non-racing weight (kg)

Tests of Normality

	Type of Jockey	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Relaxed weight Kg	NH	.161	28	.062	.901	28	.012
	Flat	.354	12	.000	.749	12	.003
	DP	.227	5	.200*	.910	5	.468

a. Lilliefors Significance Correction

*. This is a lower bound of the true significance.

Flat and National Hunt jockeys

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Relaxed weight Kg is the same across categories of Type of Jockey.	Independent-Samples Mann-Whitney U Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Dual Purpose and National Hunt jockeys

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Relaxed weight Kg is the same across categories of Type of Jockey.	Independent-Samples Mann-Whitney U Test	.001	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Dual Purpose and Flat jockeys

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Relaxed weight Kg is the same across categories of Type of Jockey.	Independent-Samples Mann-Whitney U Test	.008	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Appendix G – Outputs for tests of difference in lowest riding weight between jockey codes

Test of Normality for jockeys lowest riding weights (kg)

Tests of Normality

	Type of Jockey	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Lowest riding weight	NH	.198	29	.005	.794	29	.000
	Flat	.248	12	.041	.875	12	.077
	DP	.248	5	.200*	.953	5	.757

a. Lilliefors Significance Correction
*. This is a lower bound of the true significance.

National Hunt and Flat jockeys

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Lowest riding weight is the same across categories of Type of Jockey.	Independent-Samples Mann-Whitney U Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

National Hunt and Dual Purpose jockeys

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Lowest riding weight is the same across categories of Type of Jockey.	Independent-Samples Mann-Whitney U Test	.004	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Flat and Dual Purpose jockeys

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Lowest riding weight is the same across categories of Type of Jockey.	Independent-Samples Mann-Whitney U Test	.002	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Appendix H – Outputs for tests of difference between non-racing weight and lowest riding weight for all jockey codes

National Hunt jockeys

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Relaxed Weight and Lowest Weight equals 0.	Related-Samples Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Flat jockeys

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Relaxed Weight and Lowest Weight equals 0.	Related-Samples Wilcoxon Signed Rank Test	.433	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Dual Purpose jockeys

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	Relaxed Weight - Lowest Weight	.62000	2.36157	1.05612	-2.31227	3.55227	.587	4	.589

Appendix I- Output for test of difference in career duration and number of rides per week between jockey codes

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Career Duration is the same across categories of Jockey type.	Independent-Samples Kruskal-Wallis Test	.061	Retain the null hypothesis.
2	The distribution of Rides per week is the same across categories of Jockey type.	Independent-Samples Kruskal-Wallis Test	.135	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Appendix J-Output for test of difference in food choices

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Irregular meal times is the same across categories of Jockey code.	Independent-Samples Kruskal-Wallis Test	.867	Retain the null hypothesis.
2	The distribution of Too tired to cook is the same across categories of Jockey code.	Independent-Samples Kruskal-Wallis Test	.512	Retain the null hypothesis.
3	The distribution of Can't cook is the same across categories of Jockey code.	Independent-Samples Kruskal-Wallis Test	.278	Retain the null hypothesis.
4	The distribution of Availability is the same across categories of Jockey code.	Independent-Samples Kruskal-Wallis Test	.449	Retain the null hypothesis.
5	The distribution of Can't prepare food is the same across categories of Jockey code.	Independent-Samples Kruskal-Wallis Test	.422	Retain the null hypothesis.
6	The distribution of No time to cook is the same across categories of Jockey code.	Independent-Samples Kruskal-Wallis Test	.342	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Appendix K – Output for tests of difference in weight control methods

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Food Restriction is the same across categories of Jockey code.	Independent-Samples Kruskal-Wallis Test	.239	Retain the null hypothesis.
2	The distribution of Fluid Restriction is the same across categories of Jockey code.	Independent-Samples Kruskal-Wallis Test	.238	Retain the null hypothesis.
3	The distribution of Sauna is the same across categories of Jockey code.	Independent-Samples Kruskal-Wallis Test	.181	Retain the null hypothesis.
4	The distribution of Laxatives is the same across categories of Jockey code.	Independent-Samples Kruskal-Wallis Test	.641	Retain the null hypothesis.
5	The distribution of Appetite Suppressants is the same across categories of Jockey code.	Independent-Samples Kruskal-Wallis Test	.302	Retain the null hypothesis.
6	The distribution of Riding Exercise is the same across categories of Jockey code.	Independent-Samples Kruskal-Wallis Test	.168	Retain the null hypothesis.
7	The distribution of Other Exercise is the same across categories of Jockey code.	Independent-Samples Kruskal-Wallis Test	.232	Retain the null hypothesis.
8	The distribution of Hot Exercise is the same across categories of Jockey code.	Independent-Samples Kruskal-Wallis Test	.797	Retain the null hypothesis.
9	The distribution of Sweat suit Exercise is the same across categories of Jockey code.	Independent-Samples Kruskal-Wallis Test	.857	Retain the null hypothesis.
10	The distribution of Hot salt bath is the same across categories of Jockey code.	Independent-Samples Kruskal-Wallis Test	.537	Retain the null hypothesis.
11	The distribution of Cigarrettes is the same across categories of Jockey code.	Independent-Samples Kruskal-Wallis Test	.899	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Appendix L – Output for tests of difference in physiological effects of weight control

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Muscle Cramps is the same across categories of Jockey code.	Independent-Samples Kruskal-Wallis Test	.083	Retain the null hypothesis.
2	The distribution of Fever is the same across categories of Jockey code.	Independent-Samples Kruskal-Wallis Test	.059	Retain the null hypothesis.
3	The distribution of Nausea is the same across categories of Jockey code.	Independent-Samples Kruskal-Wallis Test	.451	Retain the null hypothesis.
4	The distribution of Dizziness is the same across categories of Jockey code.	Independent-Samples Kruskal-Wallis Test	.747	Retain the null hypothesis.
5	The distribution of Fainting is the same across categories of Jockey code.	Independent-Samples Kruskal-Wallis Test	.650	Retain the null hypothesis.
6	The distribution of Stomach cramps is the same across categories of Jockey code.	Independent-Samples Kruskal-Wallis Test	.625	Retain the null hypothesis.
7	The distribution of Circulation is the same across categories of Jockey code.	Independent-Samples Kruskal-Wallis Test	.075	Retain the null hypothesis.
8	The distribution of Fatigue is the same across categories of Jockey code.	Independent-Samples Kruskal-Wallis Test	.441	Retain the null hypothesis.
9	The distribution of Visual distortion is the same across categories of Jockey code.	Independent-Samples Kruskal-Wallis Test	.127	Retain the null hypothesis.
10	The distribution of Joint pain is the same across categories of Jockey code.	Independent-Samples Kruskal-Wallis Test	.276	Retain the null hypothesis.
11	The distribution of Physical weakness is the same across categories of Jockey code.	Independent-Samples Kruskal-Wallis Test	.603	Retain the null hypothesis.
12	The distribution of Poor reactions is the same across categories of Jockey code.	Independent-Samples Kruskal-Wallis Test	.403	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Appendix M – Output for tests of difference in psychological effects of weight control

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Persistent thirst is the same across categories of Jockey code.	Independent-Samples Kruskal-Wallis Test	.133	Retain the null hypothesis.
2	The distribution of Persistent hunger is the same across categories of Jockey code.	Independent-Samples Kruskal-Wallis Test	.427	Retain the null hypothesis.
3	The distribution of Short term memory loss is the same across categories of Jockey code.	Independent-Samples Kruskal-Wallis Test	.149	Retain the null hypothesis.
4	The distribution of Long term memory loss is the same across categories of Jockey code.	Independent-Samples Kruskal-Wallis Test	.242	Retain the null hypothesis.
5	The distribution of Mood swings is the same across categories of Jockey code.	Independent-Samples Kruskal-Wallis Test	.220	Retain the null hypothesis.
6	The distribution of Anxiety is the same across categories of Jockey code.	Independent-Samples Kruskal-Wallis Test	.131	Retain the null hypothesis.
7	The distribution of Depression is the same across categories of Jockey code.	Independent-Samples Kruskal-Wallis Test	.744	Retain the null hypothesis.
8	The distribution of Anger is the same across categories of Jockey code.	Independent-Samples Kruskal-Wallis Test	.122	Retain the null hypothesis.
9	The distribution of Sleep disturbance is the same across categories of Jockey code.	Independent-Samples Kruskal-Wallis Test	.086	Retain the null hypothesis.
10	The distribution of Tired is the same across categories of Jockey code.	Independent-Samples Kruskal-Wallis Test	.460	Retain the null hypothesis.
11	The distribution of Difficulty concentrating is the same across categories of Jockey code.	Independent-Samples Kruskal-Wallis Test	.859	Retain the null hypothesis.
12	The distribution of Poor reactions is the same across categories of Jockey code.	Independent-Samples Kruskal-Wallis Test	.810	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.